FISHERY RESEARCH

JOB COMPLETION REPORT, PROJECT F-73-R-12

Subproject IV: RIVER AND STREAM INVESTIGATIONS
V: Wood River Fisheries Investigations
Job 1: Fish Distribution, Abundance and Movements
Job 2: Angler Use, Harvest and Opinions
Job 3: Evaluation of Angling Regulations

by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (Continued)

Page

LIST OF FIGURES (Continued)

LIST OF APPENDICES

LISTS

LIST OF APPENDICES (Continued)

LISTS

JOB COMPLETION REPORT

State of: **Idaho**

Name: **River and Stream Investigations**

Project No.: **F-73-R-12**

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Title: **Wood River Fisheries Investigations**

Study No.: **V**

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ABSTRACT

In 1986, we began evaluating the status of trout populations in the Big Wood River. Project goals were to 1) determine what factors may be limiting the population, and 2) propose management direction.

The Big Wood River supports a self-sustaining population of wild rainbow trout. Taxonomists believe the trout may represent a unique stock. Trout exhibit seasonal movements characterized by upstream migrations in spring to spawning sites. Rainbow trout in the drainage are of a late-spawning stock and fish remain on redds through June 15. As a result of migration barriers and differences in habitat quality, trout are segregated into sub-populations below the Glendale diversion and above Warm Springs Creek. Consequently, trout abundance is not evenly distributed and ranges from 30 trout/km (>200 mm) in headwater areas, to 400 trout/km in the most productive reaches downstream from Warm Springs Creek. Within the most productive areas, 22% of the population of 200 mm trout exceed 300 mm, 4% exceed 400 mm and 0.5% exceed 500 mm. Two distinct growth patterns occur and trout above Warm Springs grew slower than fish in downstream areas. Growth rates in the most productive areas are comparable to rates in other productive Idaho trout streams as the Henry's Fork Snake River. Annual mortality rates are large, ranging from 65-90%. Habitat alterations have contributed to the decline of the wild trout population through diversion of water, residential encroachment, and agricultural development of floodplain areas.

RTABSTR

A substantial sport fishery occurs on the river with more than 60,000 hours of effort averaging 800 hours/km. Effort increases during June and July, peaks in August, and declines thereafter. Catch rates (harvest + release) average more than 1.0 fish/h. A substantial portion (66%) of the catch is released, and anglers in some sections release more than 70% of their catch. Anglers release most trout less than 250 mm and select larger fish to harvest. During drought years, large (>300 mm) spawning trout are more vulnerable to harvest: Approximately 7% of the annual harvest occurs during the winter season. Anglers harvest approximately 65% of the trout larger than 200 mm. It appears that natural mortality rates increase as angler harvest decreases. Sixty seven percent of the anglers are Idaho residents and 46% use bait. Although most anglers considered the fishing good or excellent, a majority would support more restrictive regulations if the size of trout increased.

Depending on the biological and social management objectives, a variety of regulations can be used to reduce angler harvest and increase the size of trout. Size limits are the most effective regulations to increase the size structure of the population. Trout abundance is primarily' regulated by the capacity of the habitat. Sport fishing for wild rainbow trout in the Big Wood River will require management plans designed to protect and restore habitat and adequately manage harvest.

Future research could include an evaluation of the biological and sociological responses to the implementation of new regulations.

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INTRODUCTION

Rainbow trout *Oncorhynchus mykiss* have provided a popular and valuable fishery in the Big Wood River since settlement of the drainage. Historically, the river was recognized as a premier wild trout water in Idaho and large (>2 kg) trout were common in the catch. As a result of human induced changes in the drainage, the abundance of wild trout declined. In 1986, the Idaho Department of Fish and Game (IDFG) initiated an intensive fishery investigation of the Big Wood River. The project was designed to evaluate the current status of trout populations, define factors limiting the population, and provide recommendations to aid restoration of the fishery.

Study results suggest that habitat alterations have profoundly reduced the resilience of the trout population and contributed to its decline. Two principle factors have influenced this decline: 1) Extensive diversion of water for irrigation continues to impact trout by dewatering stream reaches, blocking spawning movements, entrapment of fish in canals, and disruption of stream channels (Thurow 1988). 2) Residential and agricultural development of the floodplain has severely altered trout habitat through channel relocation, channel clearance, diking, and riprapping. Irizarry (1969) and Thurow (1987) found an 80-90% decline in trout densities in altered reaches.. Concurrent with the habitat losses has been an increase in angler effort as a result of human population,increases and more summer visitors. The population of the upper Wood River Valley increased by 123% between 1960 and 1980, while Idaho's population increased by 41% (U.S. Dept. of Commerce 1984).

Sport fishing for wild rainbow trout in the Big Wood River will not be maintained without an integrated management plan designed to protect and restore habitat and adequately manage harvest. Unfortunately, habitat restoration efforts are likely to be slow and unspectacular. Trout populations will benefit if measures are applied to maintain existing habitat, restore channel stability and riparian vegetation, and reduce irrigation impacts. A project testing the effectiveness of habitat restoration is in progress and a proposal has been submitted to evaluate measures to reduce irrigation impacts. Concurrently, data has been collected to enable evaluation of a series of angling regulations.

This report describes the dynamics of the existing trout populations in the upper Big Wood River drainage and summarizes the relationship between the fish population and various levels of angler exploitation. A simple modeling approach was used to evaluate a series of regulations applied to the existing population. Responses of the population to various regulations and results of angler preference surveys are discussed. The goal of this analysis is to provide management alternatives for regulations.

This document is a Completion Report for Jobs 1, 2 and 3. Results of irrigation surveys (Job 4) were reported in Thurow (1988). Separate reports will address data from the Little Wood River (Job 3) and alternatives for habitat management (Job 5). Research was supported by Federal Aid in Fish Restoration funds.

OBJECTIVES

Job No. 1: Fish Distribution, Abundance and Movements

1. To assess the abundance, distribution, and age structure of fish stocks in the Big Wood River and principal tributaries.

2. To characterize movement patterns of the spawning and rearing phases of rainbow and brown trout in the Big Wood River.

Job No. 2: _ Angler Use, Harvest and Opinions

1. To estimate angler effort and harvest on selected areas of the Big Wood River.

2. To survey angler opinions and preferences on selected areas of the Big Wood River.

Job No. 3: __ Evaluation of Angling Regulations

1. To compare fish populations in general regulation sections of similar habitat with fish populations within the following special regulation sections: Big Wood-Hulen Meadows to North Fork; Little Wood-"Bear Tracks" Williams State Recreation Area.

2. To compare angler effort, catch and angler opinions within special regulation and general regulation stream sections.

3. To evaluate movements of fish stocks between special regulation and general regulation stream sections.

RECOMMENDATIONS

1) To reduce potential conflicts with wild trout and improve return rates of hatchery trout catchables should be confined to stream reaches: 1) Where natural recruitment is lacking or inadequate; 2) Which have suitable access to produce large levels of effort; 3) Which contain suitable holding water; and, 4) Which are fished by anglers who prefer a yield type of fishery. Four reaches of the mainstem Big Wood River meet most of these criteria: Broadford Bridge to Star Bridge, the KOA campground, Adams Gulch Bridge to Sun Peak Park, and upstream from the Wood River campground. No more than 100 trout/km should be stocked at a single time.

2) More restrictive regulations have been imposed on reaches of the Big Wood River for 1990. Because of uncertainties of population responses and the accuracy of our modeling projections, an evaluation of the biological response of the trout population should be conducted within three years.

3) Angler opinions and preferences were an integral component in formulating regulatory alternatives for the Big Wood River. The sociological response of anglers to the new regulations is uncertain and should be assessed for changes in effort, angler type, and angler opinions.

4) Taxonomists have described wild trout from the Big Wood River as exhibiting unique characteristics. We documented two distinct growth patterns of wild trout. Trout in lower -reaches grow faster and exhibit a different total length to scale radius relationship than trout in areas above Warm Springs Creek. This growth difference may be environmentally or genetically based. An electrophoretic analysis could be used to determine if two stocks exist and to evaluate the level of genetic introgression of hatchery trout in the wild population.

DESCRIPTION OF STUDY AREA

Research was confined to that portion of the Big Wood River upstream from Magic Reservoir. The Big Wood River drainage contains the largest area and most productive waters in south central Idaho (IDFG 1986). From its origin near Galena Summit, the Big Wood River flows south-southwest 99 km to its confluence with Magic Reservoir (Figure 1). Magic Dam, constructed in 1909, segregates trout populations above and below. Principal tributaries above the dam include Trail and Warm Springs creeks and the East and North forks.

Mean annual discharge for the period 1915-1983 equaled 457 ft^3/s at Hailey (USGS 1989). Maximum discharge occurs April to July and peak flows have exceeded 5,000 cfs. Annual precipitation usually exceeds 60 cm and a majority falls as snow. The snow pack sustains summer flows.

Geologically, the river flows over alluvial and fluvioglacial deposits of unconsolidated sand, gravel, and clay overlying consolidated sediments. Waters are productive as reflected in alkalinity and specific conductance levels exceeding 115 mg/l and 245 umhos/cm^2, respectively (USGS 1989). Thurow (1987) provides additional information on the study areas climate, geology, hydrology, and water quality.

Fish fauna of the Big Wood River reflect the isolation of the drainage from the Snake River by ancient lava flows. Hubbs and Miller (1942) describe the drainage as exhibiting partial isolation and disruption with faunal peculiarities. Wood River sculpin Cottus leiopomus are endemic and leatherside chubs Gila copei, a Lake

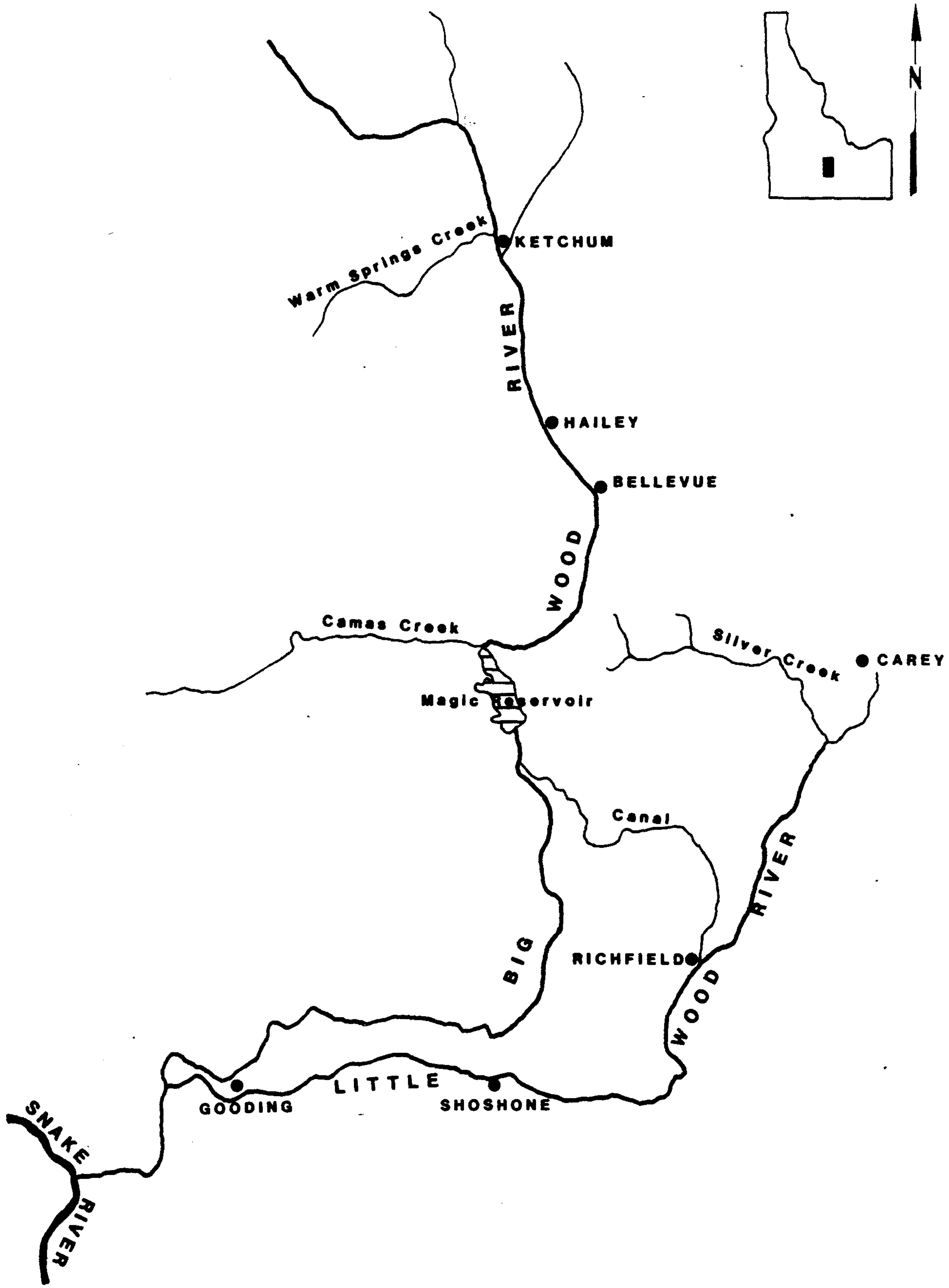


Figure 1. Wood River drainage, Idaho.

Bonneville fauna, are present. Behnke (1979) believes redband trout are the indigenous trout in the drainage and suggests that specimens in the river represent an older, relict form of redband. Recent examination of specimens from the river suggests the presence of unique morphological characteristics (Behnke 1988).

Native fish fauna are represented by four families (Catostomidae, Cottidae, Cyprinidae, and Salmonidae), seven genera, and nine species (Thurow 1987). Non-native brook trout *Salvelinus fontinalis* are present in small numbers. Cutthroat trout *Oncorhynchus clarki* occassionally enter the river from lake introductions in the headwaters. Non-native hatchery reared rainbow trout have been widely introduced as catchables to supplement angler harvest.

METHODS

Trout Population Dynamics

In 1986, we applied a stream classification system proposed by Rosgen (1985) to stratify the Big Wood River above Magic Reservoir into reaches. Four geomorphic stream types were identified (Thurow 1987). Delineation criteria included stream gradient and sinuosity (measured from topographic maps and aerial photos), channel entrenchment and valley confinement (from direct observation and topographic maps), soil-landform features (USDA-SCS 1974), and channel width to depth ratio (measured in the field). We walked or floated the entire river downstream from North Fork during the stratification.

We randomly selected seven electrofishing reaches within the geomorphic stream types (Figures 2,3). We selected multiple electrofishing reaches within some geomorphic types to enable us to compare fish populations in reaches with different habitat conditions. Based on test electrofishing, selected reaches ranged from 1,000 to 2,000 m and supported at least 100 trout/km.

From 1986 to 1988, we annually completed mark-recapture electrofishing surveys of trout populations in the seven reaches. Surveys were completed in the spring (April-May), summer (July-August) and fall (October-November). We used a 3,000-watt generator rectified to DC using a variable voltage pulsator, and applied two methods to capture trout: 1) In wadable reaches, we mounted the apparatus in a canoe which functioned as the cathode and made a single pass upstream with two mobile anodes. 2) In remaining reaches, we mounted the apparatus in an aluminum drift boat which functioned as the cathode and made three passes floating downstream with one mobile anode. All sampling was conducted during the daytime. Captured trout were measured (total length), weighed, and given a partial fin clip. Scales were collected from 10-20 trout per 50 mm size group from an area below the adipose fin and above the lateral line. Captured trout were released at

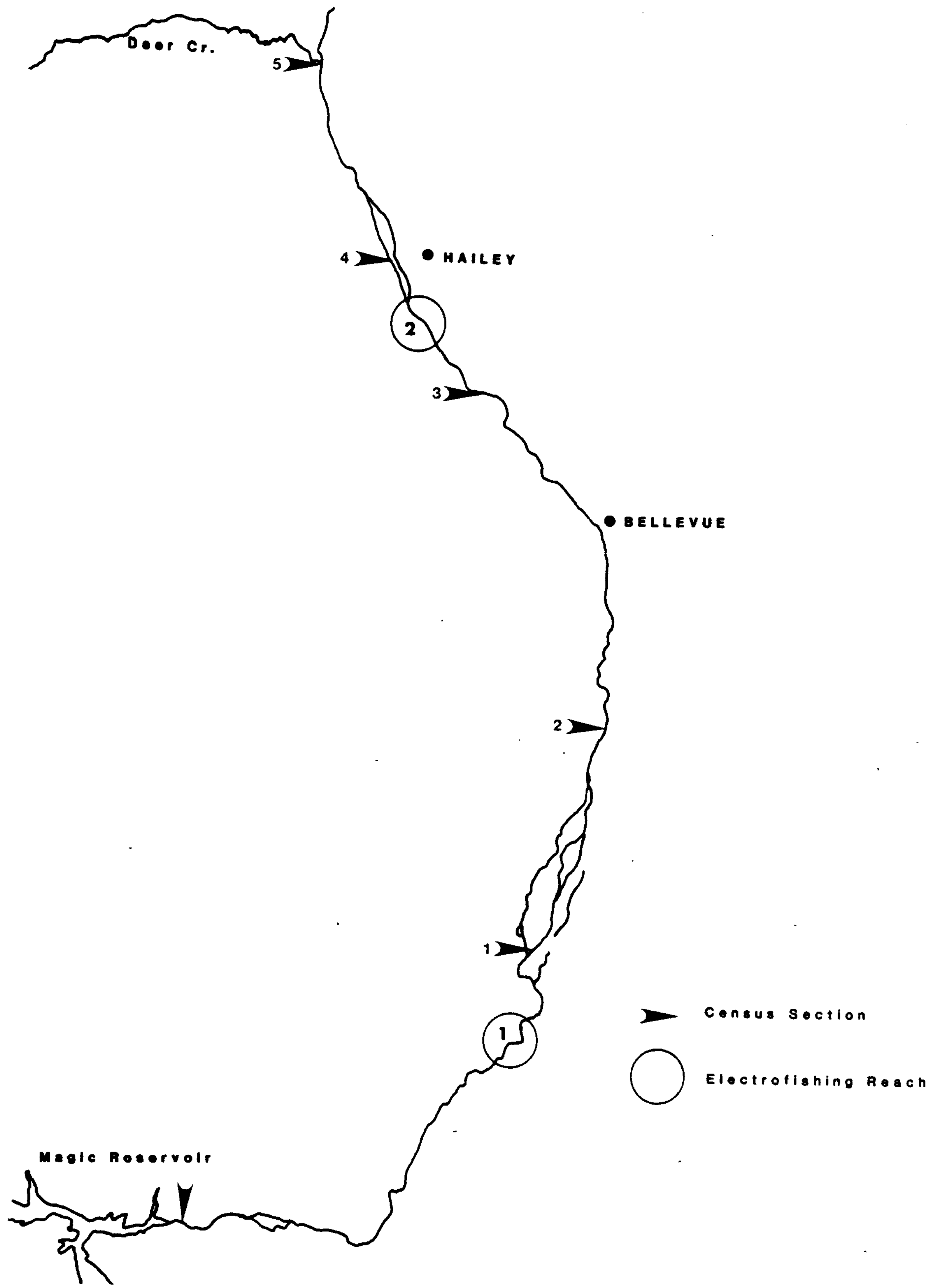


Figure 2. Map of electrofishing reaches and creel census sections below Deer Creek, Big Wood River.

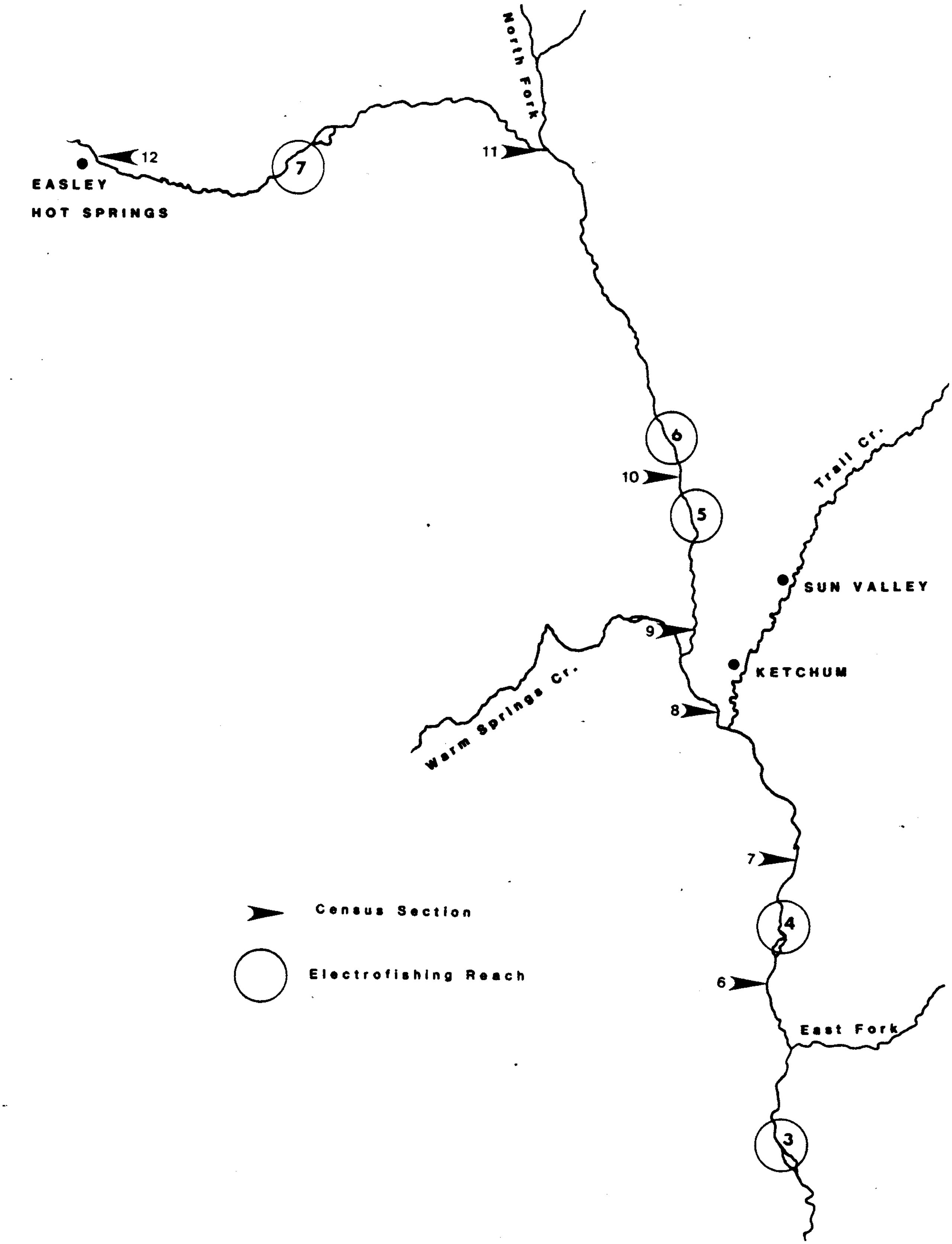


Figure 3. Map of electrofishing reaches and creel census sections above Deer Creek, Big Wood River.

the conclusion of the marking day. Approximately one week later, we re-surveyed each reach and examined trout for marks. We continued marking and returning to recapture trout until at least 20% of the recapture sample was previously marked. We measured the total length and mean width of each reach and calculated the surface area.

Movements of trout were evaluated by recapturing marked trout. In addition to fin clips, we also tagged trout larger than 250 mm with individually numbered Floy tags. We recaptured marked fish during electrofishing surveys and solicited tag return data from anglers using news releases, posting of informational signs, and placing tag deposit boxes in local establishments. To evaluate movements of hatchery-reared trout, Hayspur hatchery personnel jaw tagged 200 catchables in 1987. Lots of 100 trout each were released at the Sunpeak Park and North Fork Campground.

To determine if our sampling gear was size selective, we compared the recapture to marks-at-large ratio by 50 mm size groups (Lagler 1978). We corrected our estimates of abundance, size structure and mortality for size selectivity.

We estimated seasonal trout abundance using Chapman's modifications of the Peterson single mark-recapture formula and the Schnabel multiple mark-recapture formula (Ricker 1975). To accomodate size selectivity, we made separate estimates of abundance by 100 mm size classes and pooled them.

Size structure was estimated from length-frequency distributions pooled from 1986-88. We expressed the size structure as the percent of the population larger than 300 mm and 400 mm. We corrected size data for size selectivity by dividing the observed frequency in each 50 mm size class by its relative vulnerability (Lagler 1978).

We plotted the relationship between length and weight with the regression equation $W=aL^b$. Where W=weight (g), L=total length (mm) and a and b are parameters (Ricker 1975).

Growth was estimated by scale analysis. We made impressions of trout scales on acetate slides using a lab press with heated plates. Scales were read on a microprojector with a 6.5 mm lens. We recorded the total number of annuli and measured the distance from the focus to each annulus along the median anterior radius. We back-calculated length-at-age from scale measurements using a standard proportion method (Everhart et. al. 1975). We estimated mean length-at-age and used an analysis of variance to test for differences in growth between reaches.

Mortality was estimated by plotting catch curves using age-frequency data calculated from length-frequency data and length-at-age data. We estimated total annual mortality by fitting a linear regression through the right limb of the catch curves to estimate slope ($\log^e$ of age-frequency against age) (Ricker 1975). We corrected total annual mortality estimates by using length-frequency data corrected for size selectivity by dividing each size group by its relative vulnerability.

Exploitation was estimated by three methods: First, we compared harvest and pre-season population estimates as E = Hst/N by year (Rieman 1983).

Where: Hst = total season harvest of wild trout >200 mm.

And: N = pre-season population estimate of wild trout >200 mm. Each summer population estimate was corrected to a pre-season population estimate by adding the estimated number of trout harvested prior to the first summer marking day to the summer population estimate.

With variance: $\hat{V}(E) = 1/N^2 \hat{V}(Hst) + Hst^2/N^4 \hat{V}(N)$

And confidence interval: $E \pm 2x \hat{V}(E)$

We estimated exploitation by size groups (201-300 mm, 301-400 mm, >401 mm) by adjusting both harvest and population estimates with the appropriate length frequency.

As a second method, we used the identical formula listed above, but estimated Hst by a different method. Hst was derived by estimating the trout harvest prior to the first summer marking run and adding it to the trout harvest during the remainder of the season.

The change in the population from pre-season to fall was used as a third method to estimate exploitation as E = N-Nf/N.

Where: N = pre-season population estimate of wild trout >200 mm.

And: N+ = fall population estimate of wild trout >200 mm.

No confidence intervals were estimated for methods two or three.

We applied all three methods to estimate exploitation in Reaches 2-4. Within Reach 6, no legal harvest occurred and we assumed a 10% level of exploitation to reflect maximum hooking mortality on trout caught with lures and flies (Mongillo 1984).

We conducted redd counts of rainbow and brown trout. Between April 15 and June 20, we walked and visually surveyed reaches of the Big Wood River in search of rainbow trout redds in 1987 and 1988. We recorded the number and location of all redds and spawning trout. From 1986 to 1988 we annually surveyed the Big Wood River downstream from the confluence of the Baseline Bypass canal in search of brown trout redds. We walked the reach to its confluence with Magic Reservoir slackwater between November 15 and 20. We recorded the number and location of all spawners and redds.

Creel Census

We used geomorphic stream type, angling regulations and fishing access to divide the Big Wood river into 12 creel census sections (Figures 2,3). We censused eight sections covering 51 km in 1986 and four sections covering 36.8 km in 1987. The census was repeated in three sections (4, 7, and 11) in 1987 for comparison. As part of an effort to monitor the effects of drought in 1988, we repeated the census in sections 4, 6, and 7 for ten weeks.

A stratified random angler-count census was applied to estimate angler effort and harvest (Malvestuto 1983). The census was stratified by 14-day interval and day type (weekday, weekend, holiday). Within each interval, we randomly selected two weekdays and two weekend days and included all holidays for counts. We completed three counts per day, with count times selected randomly and adjusted by daylight hours. During counts, a clerk surveyed the river by section and recorded the total anglers fishing. Within sections 1, 5, and 9, dense riparian vegetation restricted our ability to observe anglers. To compensate, we recorded vehicle counts when no anglers could be found and applied a correction factor of 1.8 anglers per vehicle (based on a sample of 692 vehicles) to estimate total anglers.

Harvest and release rates were obtained by direct interviews with anglers in each interval. During interviews, we collected data on size and species of trout caught, angling methods, and angler residence.

Angler opinions and preferences were assessed by two methods. In 1987, we conducted interviews with.209 anglers on the Big Wood River. In 1988, an angler opinion survey was mailed to a sample of resident and nonresident license buyers (Reid 1989). A total of 195 respondents listed the Big Wood River as the water they fished most often. We summarized the responses from this group.

Total angler effort per interval was estimated by multiplying the mean angler count per day type times the number of days of that type, times the mean daylight hours per interval and summing estimates for each day type. Total estimated harvest per interval was calculated as the total angler hours per interval times the mean harvest rate (by species) per interval. Harvest and catch (harvest + release) rates were estimated for the season by considering the season as one interval, or by weighted means from each interval where data was sufficient. Total effort and harvest was estimated as the sum of the intervals. Rieman {1983) provides a complete description of the equations used to calculate estimates, and the variance and confidence intervals of the estimates.

We estimated the total annual angler effort by expanding effort estimates for sections censused in 1986, by the mean percent increase from 1986 to 1987 in replicated sections. Expanded 1986 estimates were summed with effort estimates for sections censused in 1987. Angler effort was standardized by dividing effort by the total length of stream in each section.

Population Simulations

A simple modeling approach was used to evaluate the response of trout populations in the Big Wood River to various levels of angler exploitation under different angling regulations. Simulations were based on empiracle data collected during the current study and on the best available published data.

We used a generalized population model, MOCPOP, designed to simulate age-structured populations (Beamesderfer 1988). The model is an adaption of one presented by Taylor (1981), except that recruitment can be stock-dependent and described by Beverton-Holt or Ricker functions or held constant (Ricker 1975). Required inputs include size-specific exploitation, growth (von Bertalanffy coefficients), age-specific maturity, age-specific natural mortality rates, length-weight coefficients, and recruitment-function coefficients. We used a sensitivity analysis to describe the influence of key population parameters. Key parameters were varied independently while other inputs were held constant. Model outputs provide annual estimates of total numbers of trout of specific sizes and ages, total harvest, and yield.

As a result of differences in growth and mortality, we segregated the simulations into Lower (downstream from Warm Springs Creek) and Upper (upstream). We did not incorporate any density-dependent variation in growth or mortality after the first age class in the model. Our observations of periodic, large, cohorts suggested that recruitment was not stock dependent at current population levels, but relatively stable with some random influence from environmental factors such as stream discharge. We assumed recruitment was stable with periodic large age classes twice the norm at intervals of 10 years. We modeled the response of the wild trout population to eight different size regulations and tested the influence of bag limits, hooking mortality, and compensatory mortality. We began the stock simulation by entering population parameters into the model and creating an approximation of the existing population run for a 30 year period. We applied different levels of exploitation to the existing population and ran it for 10 years to allow the population to reach a new equilibrium.

Within the lower river, growth was described by fitting mean length-at-age data from trout in Reaches 2-4 with the Von Bertalanffy equation to predict age classes. Maximum observed age was age 6. Coefficients for the length-weight relationship in the model were obtained from our regression of empiracle data.

Mortality was described by generating a pooled catch curve for Reaches 2-4 and regressing $\log^e$ of age frequency against age. Conditional natural mortality (u) was estimated by the formula u = 1-(s)-m. Where: s = annual survival and M = natural mortality rate. Based on our survivalship curves we set conditional natural mortality at 0.5 for trout of ages 1 and 2 and 0.25 for trout from age 3 to 6 in the model.

Exploitation was varied over the range of 0.1 to 0.8. Trout were assumed to enter the fishery at age 2 and a total length of 200 mm. We distributed exploitation disproportionately to the different size classes as we observed in the fishery. Trout in the following size groups, 200-299 mm, 300-399 mm, and >400 mm were exploited at 0.8, 1.3, and 1 times the total exploitation rate, respectively.

We tested the response of the population to four "slot limits" which allowed harvest of trout less than or larger than specified limits, three minimum size limits, and a catch-and-release regulation. To estimate exploitation rates under various regulations, we multiplied the percent of trout in each age group, which were in an exploitable size, times the apportioned exploitation rate for that size group. For example, under a 254 mm minimum size limit, 65% of the age 2 trout would exceed 254 mm. At a total exploitation rate of 0.7, trout from 200-299 mm would be exploited at the rate of 0.56 (0.7 x 0.8). The total exploitation rate for age 2 trout would equal 0.36 (0.65 x 0.56) under a 254 mm minimum size limit. Exploitation rates were calculated in this manner for each age class and tested under the various regulations.

The effects of bag limits were tested using data from creel surveys. Based on the percent of anglers harvesting between zero and six trout, we estimated the theoretical reduction in the harvest under reduced bag limits. We held exploitation constant at 0.6 and varied the bag limit. To estimate exploitation rates for size groups of trout, we multiplied the previously calculated exploitation rates times the percent of the harvest remaining under various bag limits.

We tested the effects of bait hooking mortality by applying data from the literature to our estimates of the proportion of the catch by bait anglers. A mean of 25% of the trout caught with bait and released die with a range of mortality from 5% to 60% (Wydoski 1977; Mongillo 1984). Bait anglers currently catch an average of 35% of the trout on the Big Wood River with a maximum of 60% of the catch by bait anglers in a few sections. We tested a "worst case scenario" by assuming that 60% of the trout caught with bait and released, die. Based on creel data, released trout were assumed to be caught 1.5 times during the season. We tested the effect of a 60% hooking mortality if 35% and 60% of the catch was made by bait anglers. We assumed the 60%-60% (% catch with bait-% hooking mortality) represented the maximum mortality which could be expected with bait angling under current exploitation. We held exploitation constant at 0.6 and estimated the response of the population with bait hooking mortality. To estimate angler induced mortality rates for size groups of trout, we applied the following formula: (percentage of trout released) x (percentage of catch with bait) x (hooking mortality rate with bait) x (1.5) x (exploitation rate) + (exploitation rate of harvested trout). In the model we assumed the mortality of trout caught and released with artificial flies or lures was not significant and was approximated by zero.

We also tested the effects of combining a size limit and a 2-fish bag limit with bait angling. Exploitation was held constant at 0.6. We estimated angler induced mortality rates by multiplying the exploitation rate of harvested trout by the percent of the harvest remaining under a 2-fish bag limit and adding that value to the previously calculated hooking mortality rate.

Mortality estimates suggested that compensatory mortality as Ricker (1975) discussed may occur in the Big Wood River. We tested the effects of compensatory mortality on the responses of the trout population to new regulations. We used a hypothetical relationship between exploitation and conditional natural mortality derived from empiracle data listed in Table 7 (Figure 4). As exploitation decreased, conditional mortality increased. We tested the sensitivity of the population to compensatory mortality by varying conditional mortality with exploitation. We compared the response to tests where conditional mortality was held constant.

In the upper river, growth was described by fitting mean length-at-age data from trout in Reaches 5 and 6 with the Von Bertalanffy equation. Mortality was described by generating catch curves for Reaches 5-7. Conditional natural mortality was estimated as described earlier. Within the model, we set conditional natural mortality at 0.7 for ages 1 and 2, and 0.5 for ages 3-6. Exploitation was varied over the range of 0.1 to 0.8, and trout were assumed to enter the fishery at age 2 and a total length of 200 mm. We distributed exploitation to different size classes as described earlier. We tested the response of the population in the Upper river to the same size limits tested in the Lower river. Because anglers on the river creeled similar daily bag limits of trout, we did not re-test the effects of reduced bag limits in the Upper river. We similarly tested a "worst case scenario" for bait hooking mortality as we had in the lower river but with exploitation held constant at 0.7. We estimated angler induced mortality for size groups as described earlier. The effects of combining a size limit and a 2-fish bag limit with bait angling were also tested. Angler induced mortality rates were estimated as described earlier. Finally, we tested the effects of compensatory mortality on the responses of the trout population to the regulations as described earlier.

RESULTS

<u>Current Status Of Wild Rainbow Trout</u>

Trout Population

Wild rainbow trout are the predominant game fish in the Big Wood River, comprizing an average of 85Z of the trout. The following section provides a synopsis of data describing the population dynamics of wild rainbow trout.

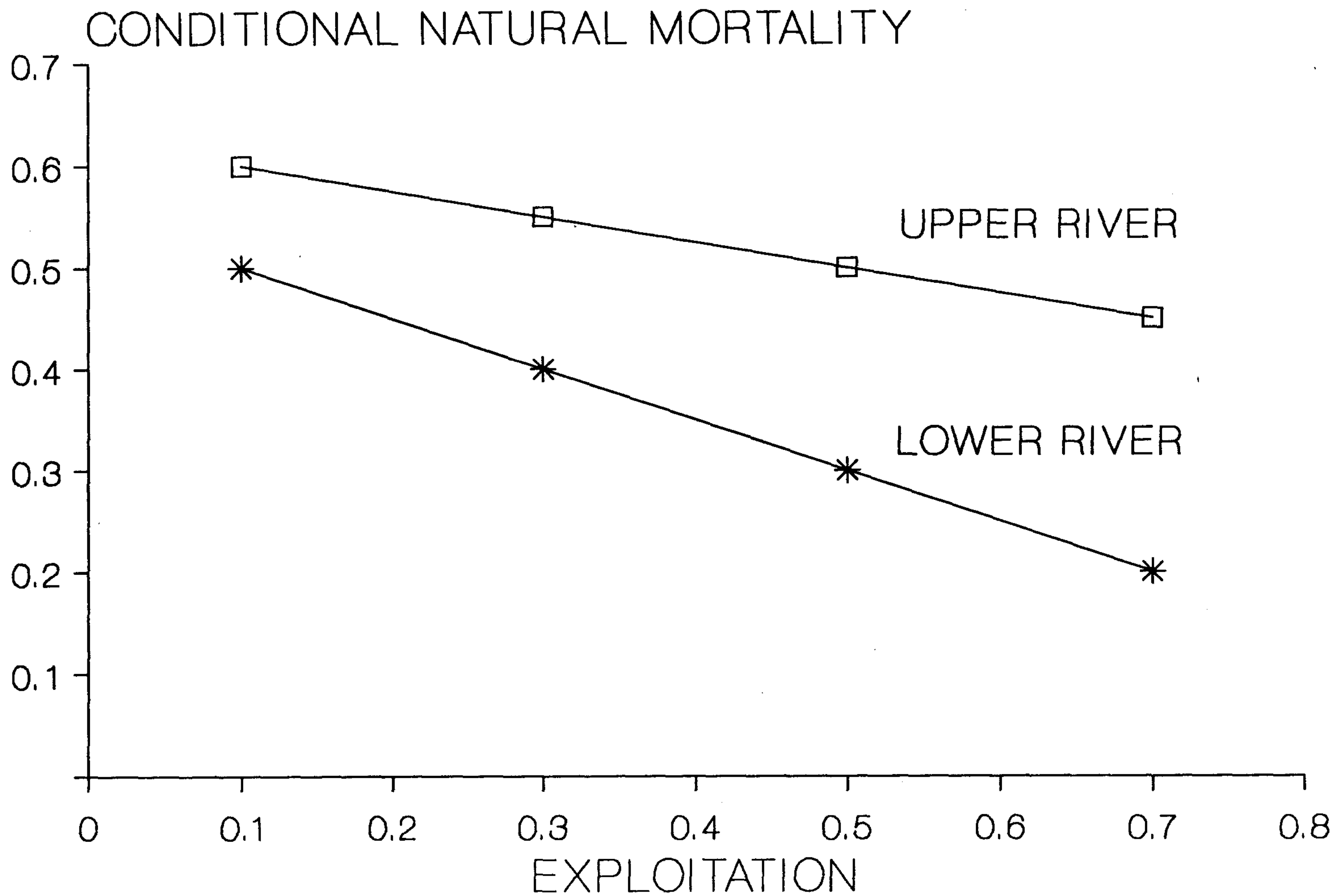


Figure 4. Hypothetical relationship between angler exploitation and conditional natural mortality, upper and lower Big Wood River.

Abundance. Summer densities of age II and older rainbow trout averaged 30 to 410 trout/km from 1986-1988 (Table 1, Figure 5). Trout were not evenly distributed spacially. Spacial differences in densities were apparent between Reach 1 (downstream from the Glendale Diversion), Reaches 2-4 (Hailey to Warm Springs Cr.), Reaches 5 and 6 (Warm Springs Cr. to North Fork), and Reach 7 (above North Fork). Reaches 2, 3, and 4 supported more than three times the density of trout present in Reaches 5 and 6. Although Reach 6 is managed as a catch-and-release (CR) area, it supported densities similar to those in Reach 5 where a harvest fishery supplimented with hatchery trout occurs. Although year to year variation in abundance occurred within individual reaches, differences were minor and confidence limits overlapped (Table 1).

Trout abundance changed between summer and fall sampling periods. Densities declined in Reaches 3 and 4 from summer to fall (Figure 5). Densities in Reaches 2 and 6 (CR) remained similar during the same period. Spring sampling did not provide reliable estimates of abundance because of the difficulty in recapturing sufficient marked trout.

Vulnerability of different size groups of trout-to our sampling gear effected our estimates of abundance. Vulnerability increased with increasing size, and trout less than 200 mm were the least vulnerable and trout larger than 350 mm the most vulnerable (Figure 6). Uncorrected estimates of the abundance of trout larger than 100 mm underestimated total abundance by an average of 18%. Uncorrected estimates of the abundance of trout larger than 200 mm were within 4% of estimates which were corrected for size selectivity. As a result, we used estimates of trout larger than 200 mm.

Size Composition. We captured 6,012 wild rainbow trout during summer electrofishing surveys from 1986-1988 (Table 2). Trout ranged from 50 to 530 mm. A very large age I year class in 1988 resulted in increased numbers of trout less than 200 mm in our 1988 sample. Numbers of trout larger than 200 mm remained similar between years. Size of trout captured varied among reaches. We captured the largest proportion of juvenile trout less than 200 mm in Reaches 1 and 5 (Table 2). The largest proportions of trout exceeding 300 mm and 400 mm were captured in Reaches 2-4 and 6. Trout exceeding 300 mm were uncommon in Reaches 5 and 7.

Vulnerability of different size groups of trout to our sampling gear effected estimates of size composition by underestimating the abundance of the least vulnerable size classes and overestimating the abundance of large trout (Figure 6). Appendix A summarizes the original length-frequency data corrected for size selectivity. This corrected data represents the best estimate of actual length frequency. Trout larger than 300 mm and 400 mm were most abundant in Reaches 2-4. Densities of 300 mm and 400 mm trout were 2.5 and 3.4 times more abundant in Reaches 2-4 than in Reach 6 (CR), respectively (Table 3).

Movements. Mature (age III and older) rainbow trout exhibited seasonal movements which differed among stream reaches. Trout from lower reaches of the river, and possibly from Magic Reservoir, migrate upstream to spawn during the spring. Most of the upstream movements

Table 1. Estimated wild rainbow trout population estimates (trout >200 mm) and densities, summer and fall, 1986-1988.

Reach	Year	Population estimate	95% confidence interval	Trout/ km	Trout/ hectare
		(Jul-Aug)			
1	1986	235	(168-496)	127	99
2	1986	352	(218-598)	176	97
	1987	544	(292-1113)	272	177
	1988	1038	(749-1483)	519	353
3	1986	460	(254-920)	431	211
	1987	244	(147-433)	229	137
	1988	392	(278-569)	367	232
4	1986	675	(431-1898)	341	197
	1987	955	(609-1577)	483	318
	1988	808	(601-1111)	408	276
5	1986	135	(55-338)	114	76
	1987	111	(58-234)	94	72
	1988	112	(34-204)	95	76
6	1986	125	(73-235)	109	72
	1987	176	(83-405)	153	104
	1988	90	(50-180)	78	54
7	1986	43	(19-108)	40	32
	1987	20	(10-40)	19	--
		(Oct-Nov)			
2	1987	583	(338-1093)	292	189
3	1986	81	(42-171)	76	37
	1987	220	(128-413)	206	123
4	1986	455	(258-878)	230	133
	1987	301	(187-512)	152	100
6	1986	168	(107-277)	146	97
	1987	161	(97-285)	140	95

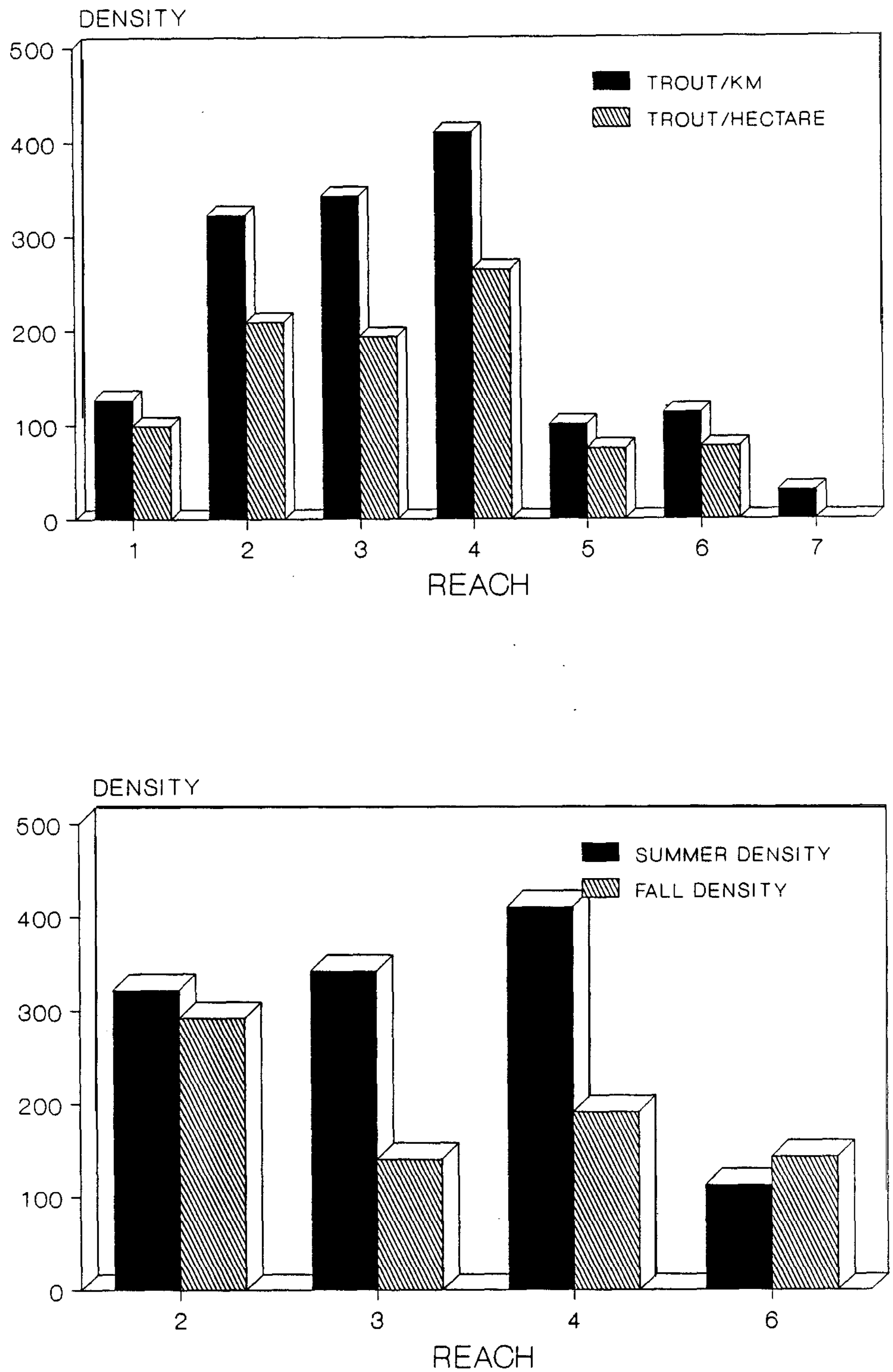
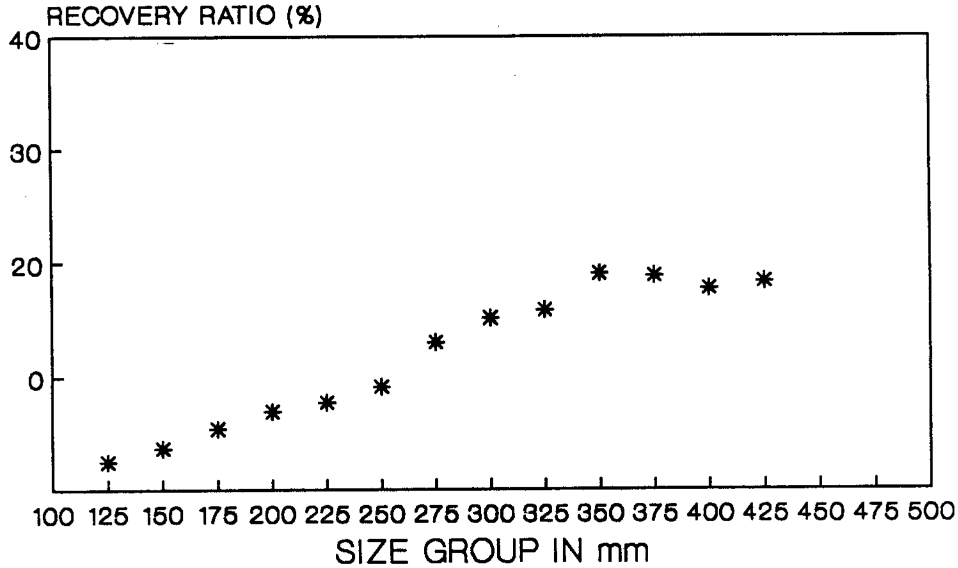


Figure 5. Summer density of wild rainbow trout by reach (top) and summer and fall densities (fish/km) of wild rainbow trout (bottom), 1986-1988.

REACH 2,3,4



REACH 1 AND 5,6,7

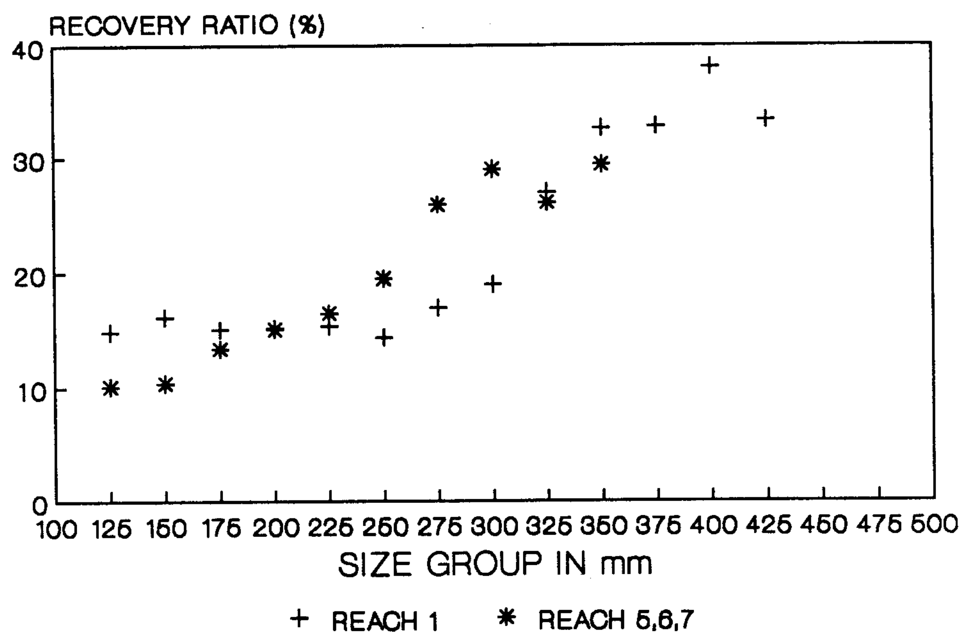


Figure 6. Vulnerability (recovery ratio) of wild rainbow trout to electrofishing, by size, 1986-1988.

Table 2. Length-frequency of wild rainbow trout captured by electrofishing, July-August.

Reach	Year	Size group (mm)										
		50-99	100-149	150-199	200-249	**250-299**	300-349	350-399	400-449	450-499	500-549	N
1	1986	7	189	126	48	23	12	15	4	0	0	424
	(%)[a]		(45.3)	(30.2)	(11.5)	(5.5)	(2.9)	(3.6)	(1.0)	(0)	(0)	
2,3,4	1986	13	149	139	137	100	60	36	17	2	0	653
	1987	25	200	105	127	155	73	63	38	4	0	790
	1988	68	1,062	1,012	480	213	73	75	65	4	2	3,054
	(%)		(28.3)	(23.1)	(18.0)	(14.3)	(7.1)	(5.5)	(3.3)	(0.3)	(0.02)	
5	1986	8	23	17	28	10	1	2	2	0	0	91
	1987	17	49	41	34	19	3	1	1	0	0	165
	1988	19	96	85	24	4	0	0	0	0	0	228
	(%)		(35.6)	(29.6)	(22.8)	(8.9)	(1.1)	(1.0)	(1.0)	0	0	
6	1986	3	16	18	21	15	11	14	4	0	1	103
	1987	6	37	52	30	10	5	3	2	0	0	145
	1988	25	76	61	23	18	8	6	2	1	0	220
	(%)		(27.2)	(28.9)	(18.2)	(10.5)	(6.2)	(6.4)	(2.2)	(0.2)	(0.2)	
7	1986	6	12	19	15	6	3	0	0	0	0	61
	1987	8	20	27	17	4	2	0	0	0	0	78
	(%)		(25.2)	(36.5)	(25.8)	(8.3)	(4.2)	0	0	0	0	
	TOTAL	205	1,929	1,702	984	577	251	215	135	11	3	6,012

[a]% is for fish larger than 99 mm.

were confined to reaches downstream from Warm Springs Creek. Spawning commences in April and continues until approximately June 15. Visual surveys of spawners and redds suggest the bulk of the mainstem spawning occurs between the Glendale Diversion and Warm Springs Creek. An additional unknown portion of the spawning occurs in tributaries. Following spawning and stabilization of summer flows, trout maintain limited home ranges as reflected by minimal movements from July through October. Limited data suggests that some downstream movement occurs between late fall and spring.

We recovered 356 floy tagged trout during electrofishing surveys and through voluntary returns from anglers. Most (81%) were recovered within one km of the original tagging site. The trout which moved displayed the following movement patterns. Trout tagged in April and May migrated upstream to recovery sites (Figures 7,8,9). Trout tagged in summer, and recovered between summer and fall, exhibited minimal movements. Trout tagged in summer or fall, and recovered in winter or the following spring or summer, exhibited downstream movements.

Recovery data suggests that interchange occurs in the trout populations downstream from Warm Springs Creek. Trout tagged in reaches 1-4 displayed upstream and downstream movements (Figures 7,8,9; Appendix B). Trout in Reaches 5-7 displayed minimal movements, and we were unable to document any interchange between Reaches 1-4 and Reaches 5-7. Only seven of 117 (6%) trout recovered in Reaches 5-7 moved more than 1 km, and none moved below Reach 5.

Growth. Two distinct growth patterns occur in the Big Wood River. Although growth is nearly linear, growth rates vary between stream Reaches. Trout in Reach 1 and Reaches 2-4 grew similarly at age I and II, and growth accelerated after age III in each 1, possibly as a' result of rearing in the productive environment of Magic Reservoir (Figure 10). Trout in Reach 6 grew substantially slower than trout in the other Reaches. A plot of the relationship between fish length and scale radius suggests that two distinct populations may exist (Figure 11). Trout in Reach 6 displayed a different body-to-scale relationship as compared to trout from Reaches 2-4. The slower growth and different body-to-scale relationship in Reach 6 may be environmentally or genetically based.

Length-weight relationships were similar for all Reaches (Thurow 1986). Based on a sample of 1,332 trout, the regression equation $W = aL^b$ where W = weight, a = 0.0000098, L = total length, and b = 3.01 with r2 = 0.98 best described the length-weight relationship.

When compared to wild rainbow trout from other, productive Idaho waters, Big Wood River trout displayed similar growth rates (Figure 10). The existing stock has sufficient growth potential and longevity to attain lengths exceeding 457 mm.

Mortality. Catch curves generated from electrofishing-based length data exhibited steeply descending right limbs. Estimated annual mortality rates of age II and older wild rainbow trout ranged from 0.65 in Reach 6 (CR) to 0.90 and 0.91 in Reaches 5 and 7, respectively (Table 4).

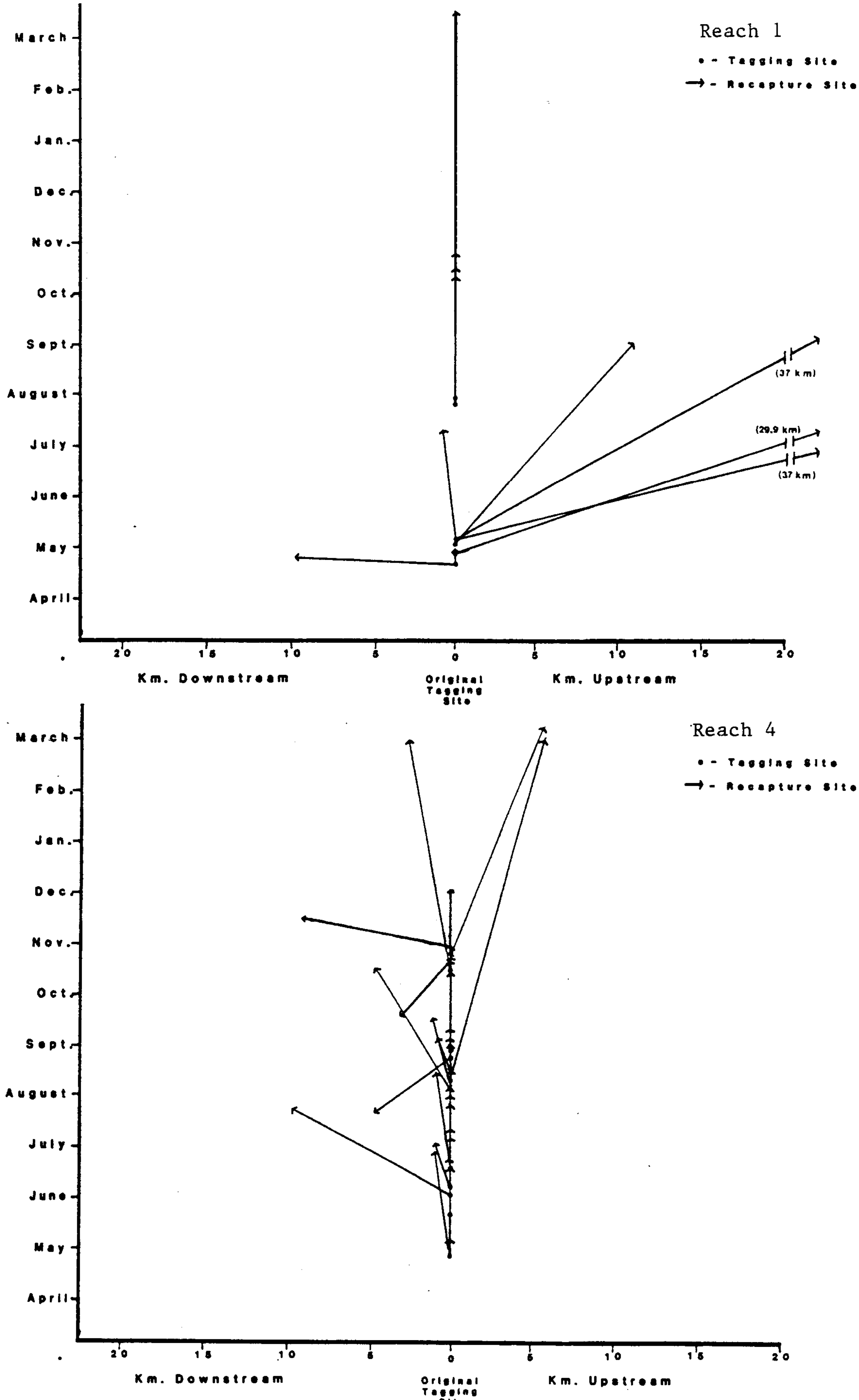


Figure 7. Seasonal movements of tagged wild rainbow trout, Reaches 1 and 4, 1986-1988.

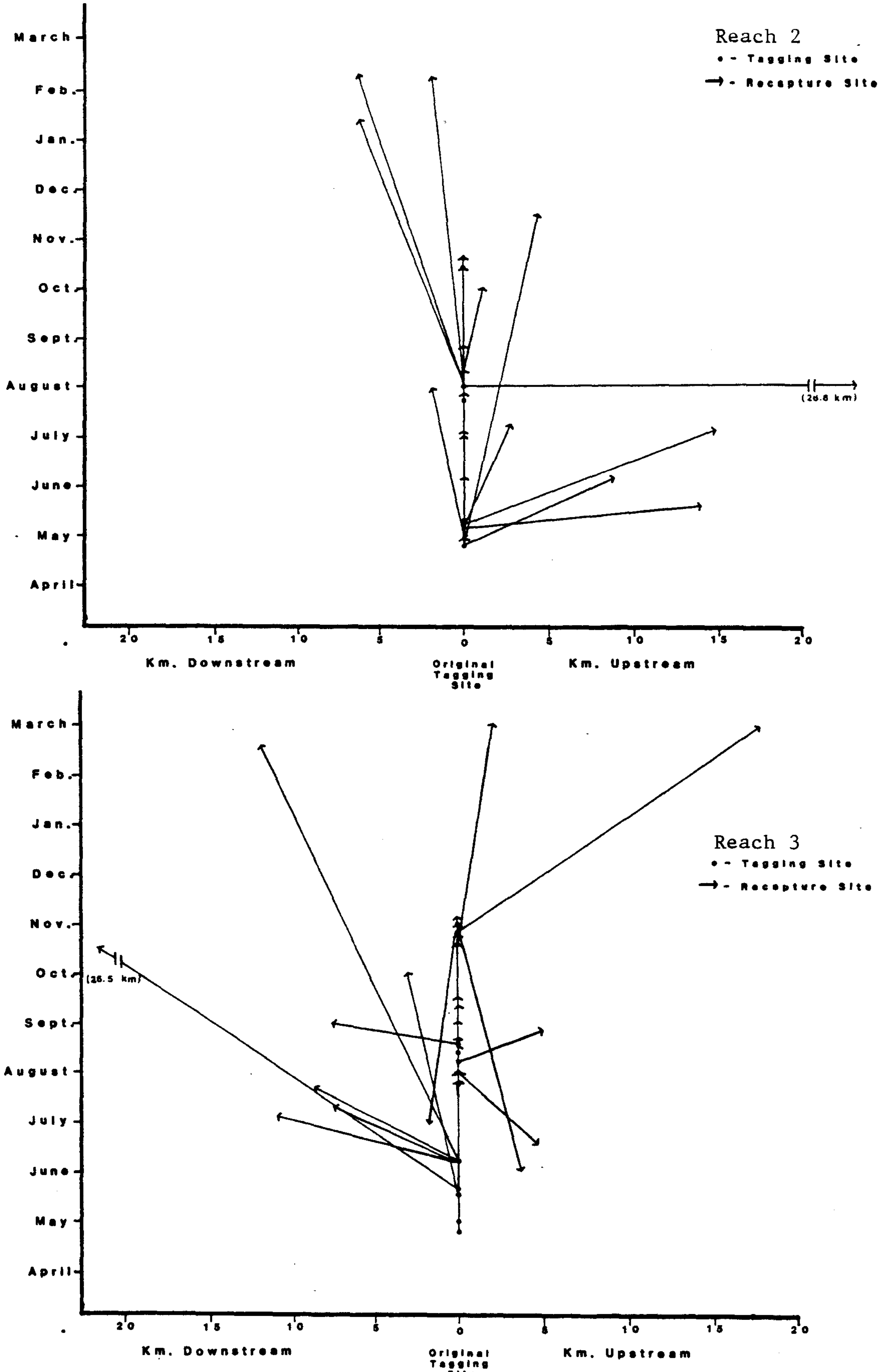
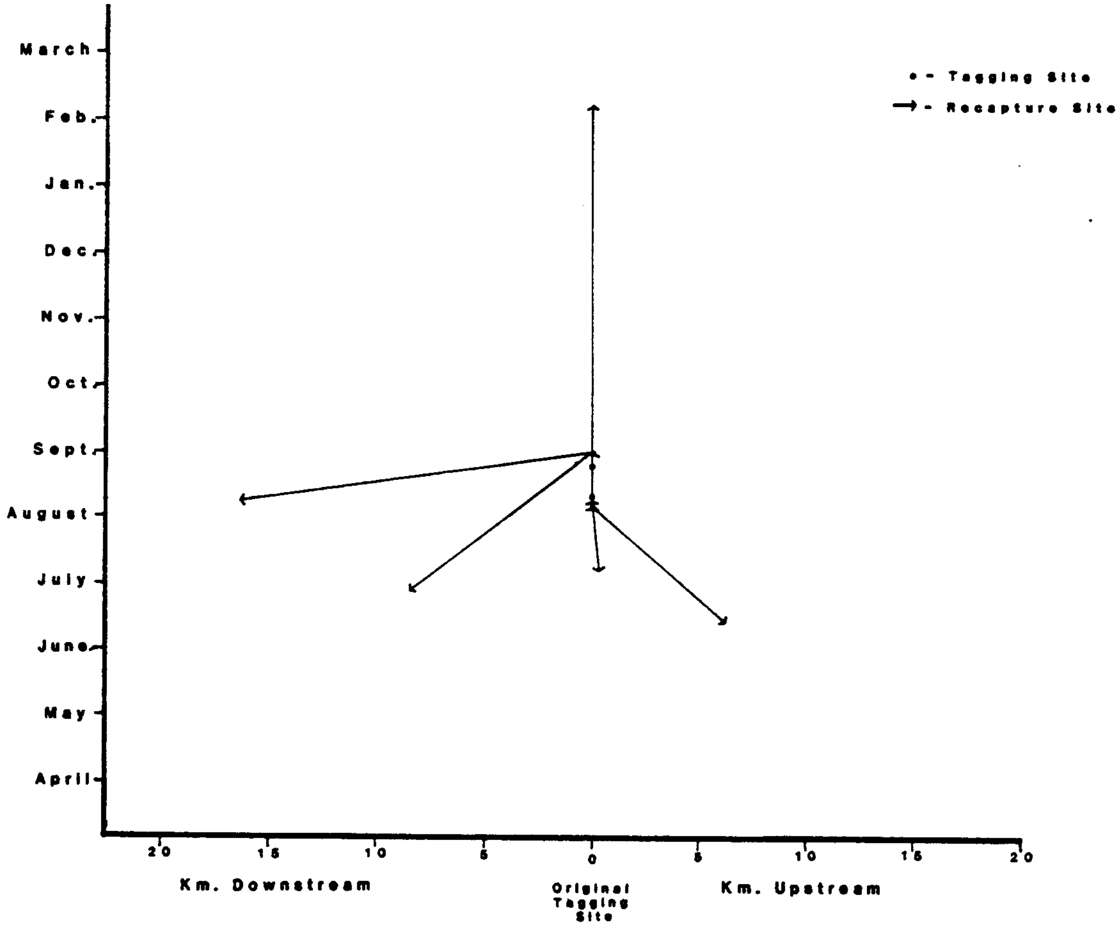


Figure 8. Seasonal movements of tagged wild rainbow trout, Reaches 2 and 3, 1986-1988.



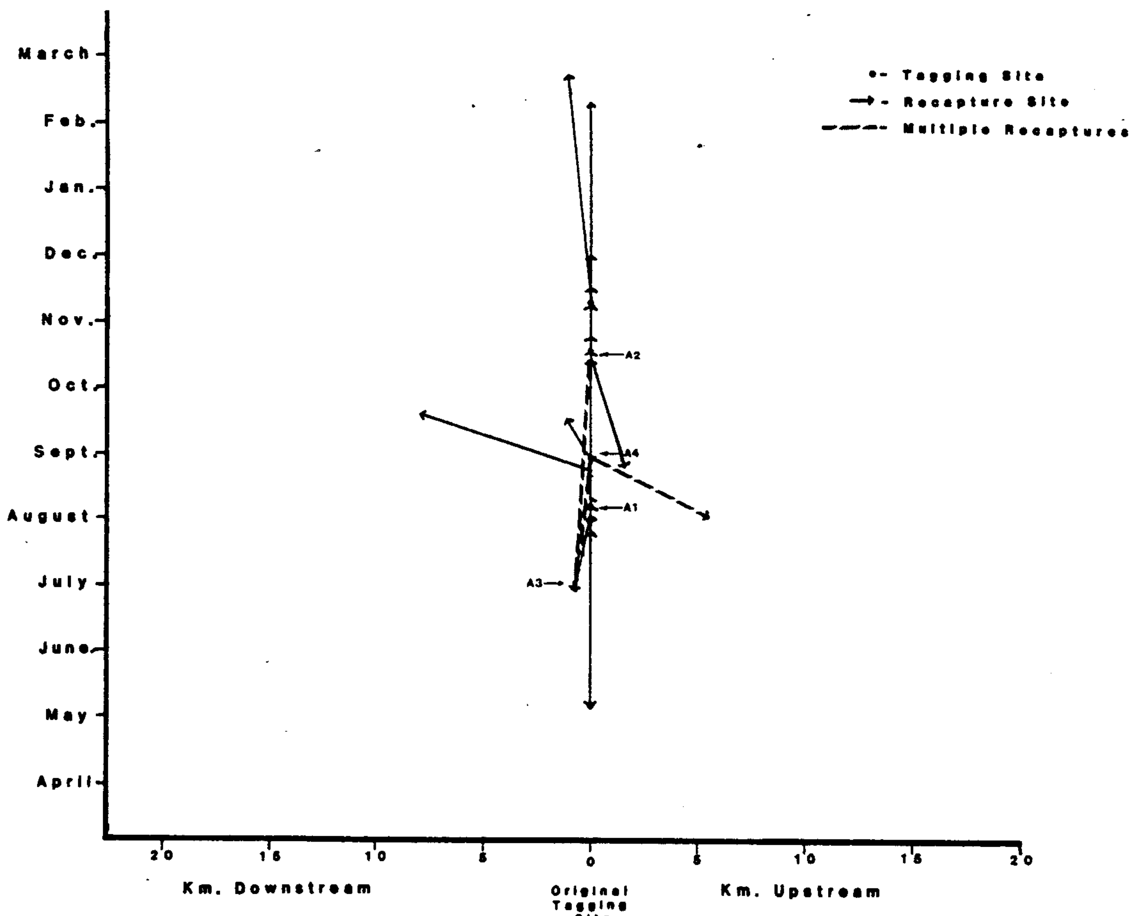


Figure 9. Seasonal movements of tagged wild rainbow trout, Reaches 5 + 7 and 6, 1986-1988.

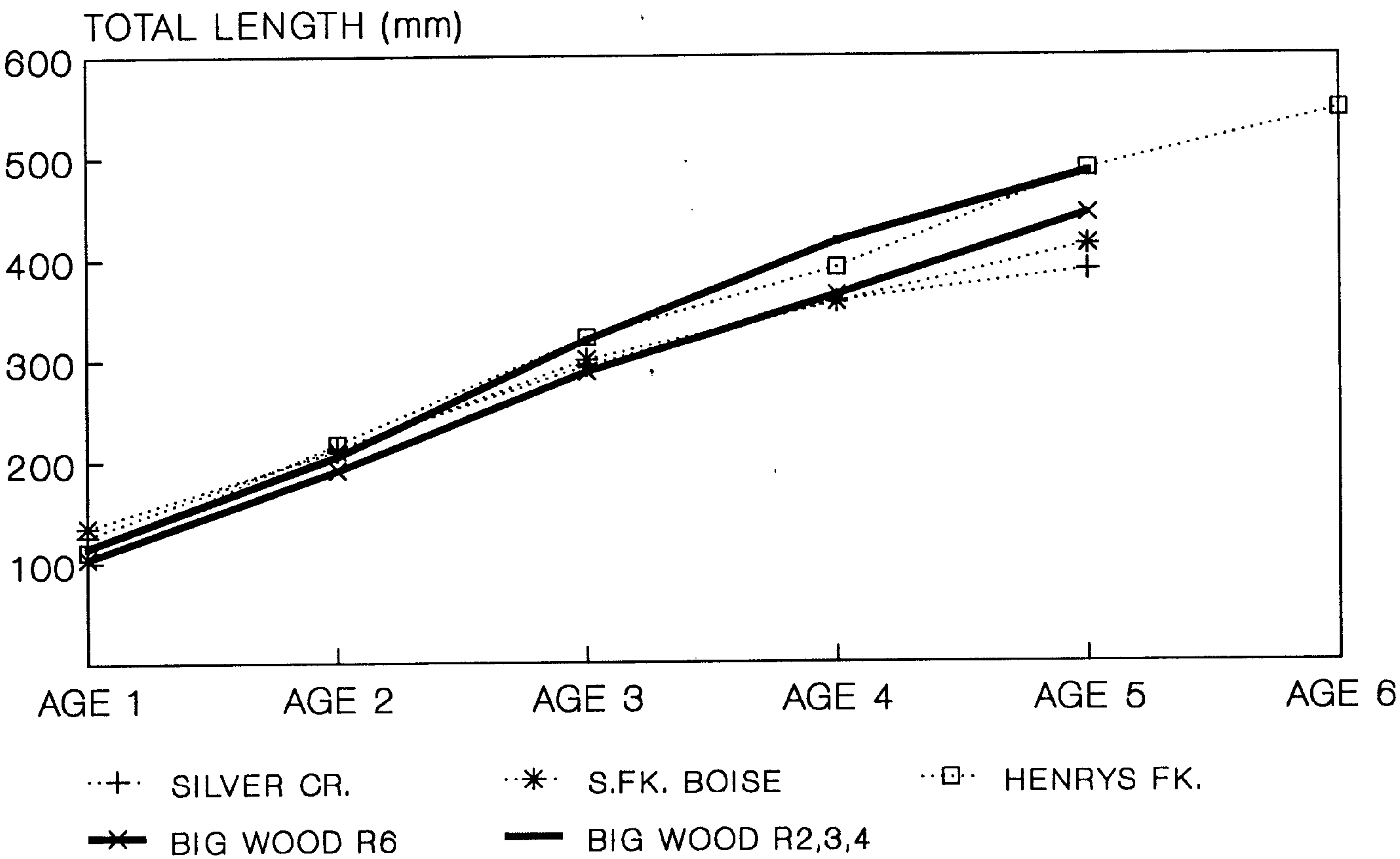


Figure 10. Length-at-age for wild rainbow trout in two reaches of the Big Wood River and from Silver Creek (Riehle and Parker 1988), Henrys Fork Snake River (Coon 1978), and South Fork Boise River (Mate 1977).

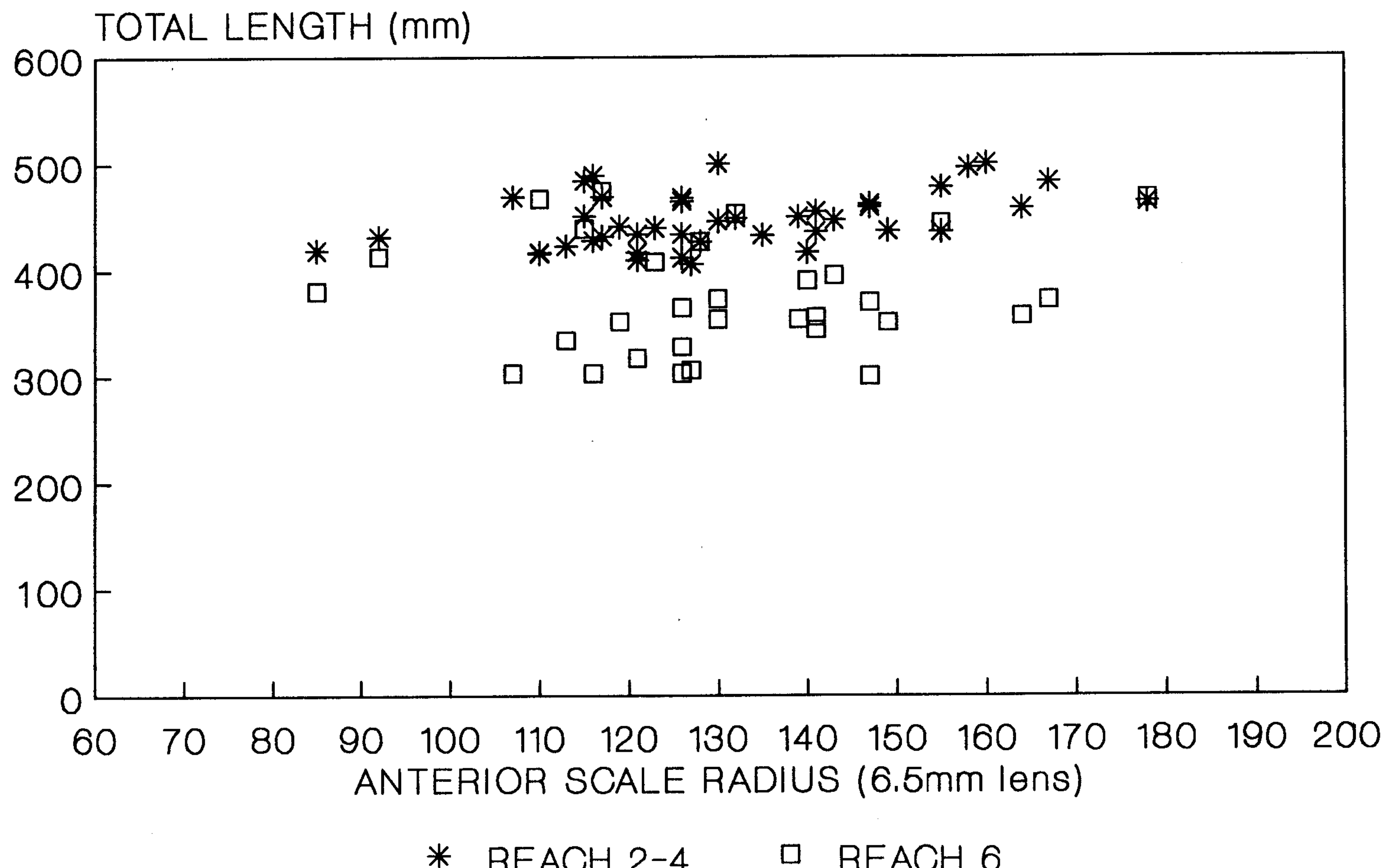


Figure 11. Relationship between anterior scale radius (ASR) and total length of wild rainbow trout, upper and lower Big Wood River.

Table 3. Estimated numbers and percentages of wild rainbow trout larger than 200 mm which exceeded 300, 400, and 500 mm, July-August, 1986-1988 pooled.

Reach	Percent >300 mm	Percent >400 mm	Percent >500 mm	trout/km >300 mm	trout/km >400 mm	trout/km >500 mm
1	18.2	1.9	0	23	3	0
2,3,4	21.2	4.6	0.05	76	17	0.2
5	5.7	1.8	0	6	2	0
6	26.2	4.3	0.4	30	5	0.4
7	7.5	0	0	2	0	0

Table 4. Total instantaneous (Z) and total annual (A) mortality estimated from catch curves for age 2-4 wild rainbow trout larger than 100 mm and 200 mm.

Stream reach	>200 mm Z	>200 mm A	>100 mm Z	>100 mm A
1	2.13	0.88	1.79	0.83
2,3,4	1.40	0.75	1.48	0.77
5	2.48	0.91	1.82	0.84
6	1.04	0.65	1.02	0.64
7[a]	2.30	0.90	1.54	0.79

[a]Ages 2-3.

RTTABLS1

Sport Fishery

Effort. Anglers fished an estimated 60,806 h on 74.3 km of the mainstem Big Wood River between May 23 and November 13, 1987 (Table 5). We censused 51 km of stream in 1986 and 36.8 km in 1987. Within identical sections, effort increased by a mean of 68Z in 1987 as compared to 1986 (Appendices C and D).

Effort was not evenly distributed spacially. Sections 7, 8, and 10 sustained the largest effort, ranging from 1,536 to 2,026 hours/km (Table 5). Effort averaged 440 to 580 angler trips/km in the most heavily fished sections. Section 2 was dewatered and stream flows in section 1 were severely reduced in mid-July 1987 by irrigation withdrawl, and these sections sustained the smallest effort. Excluding section 2, effort averaged 824 h/km and 235 angler trips/km on the remaining 68.6 km of stream we censused between Magic Reservoir and Easley Hot Springs. We did not census any tributaries, nor the mainstem Big Wood River above Easley. Total angler effort in the drainage may exceed 75,000 h during the general angling season.

Effort generally increased during June and July, peaked in late July or early August (interval 5), and declined rapidly after early September (Figure 12). The temporal distribution of effort differed between 1986 and 1987-1988. In 1986, a relatively normal snowmelt maintained high flows and turbid water conditions until mid-June (interval 1). In 1987 and 1988, abnomaily low snowpack resulted in fishable water conditions on the opening weekend (interval A). A comparison of angler effort by interval within repeated censused sections (Sections 4 and 7) illustrates the changes in effort from 1986 to 1987-1988 (Appendices C, D, and E). The Big Wood River remained open to winter angling from December 1 to March 31. Anglers fished an estimated 1,593 h on 40.3 km of stream between January 1 and March 27, 1987 (Thurow 1988). Effort averaged 40 h/km, which was less than 5% of the effort during the general season. March sustained the largest effort (55Z) during the winter census. Sections 3, 4, 6, 9, and 11 supported a majority (94Z) of the winter fishery within the censused sections. Effort was related to ease of access to the river, and much of the effort occurred near bridges.

Catch and Harvest. Catch rates (fish harvested + fish released) for all trout species averaged 1.26 fish/h, and exceeded one fish/h in 9 of 11 sections (Appendix F). In the two exceptions (sections 3 and 12) catch rates averaged 0.9 and 0.7 fish/h, respectively. Catch rates generally displayed bi-modal peaks during late June to mid-July and from late August to early September (Appendix G). Although water conditions effect annual emergence of insects, peak catch rates tend to follow the emergence of two major aquatic insects, *Ephemerella dotsi* in June, and *Ephemerella hecuba* in August.

Anglers caught an estimated 51,009 trout from 68.6 km of stream for an average of 744 trout/km in 1986 and 1987 (Appendix F). Within sections 4, 7, and 11, catch increased by a mean of 40% from 1986 to 1987. An adjusted estimate of total catch equaled 61,339.

Table 5. Total estimated angler effort by census section, 1987.

	Creel census section (km)											
	1 (10.5 km)	2 (5.7 km)	3 (9.2 km)	4 (3.2 km)	5 (4.6 km)	6 (6.8 km)	7 (2.1 km)	8 (4.6 km)	9 (2.4 km)	10 (3.7 km)	11 (8.3 km)	12 (13.2 km)	Total (74.3 km)
1986 (h)	-	-	4,222	1,954	-	3,919	2,769	4,205	-	3,484	3,635	5,035	
1987 (h)	4,616	143	7,093[a]	3,943	5,446	6,584[a]	4,255	7,064[a]	1,469	5,853[a]	5,881	8,459[a]	60,806[a]
1987 (h/km)	440	25	771	1,232	1,184	968	2,026	f,536	612	1,582	708	641	X=818 h/km

[a]Estimate based on 1986 effor adjusted by the % difference between sections 3,7,11 which were censured both years.

RTTABLS2

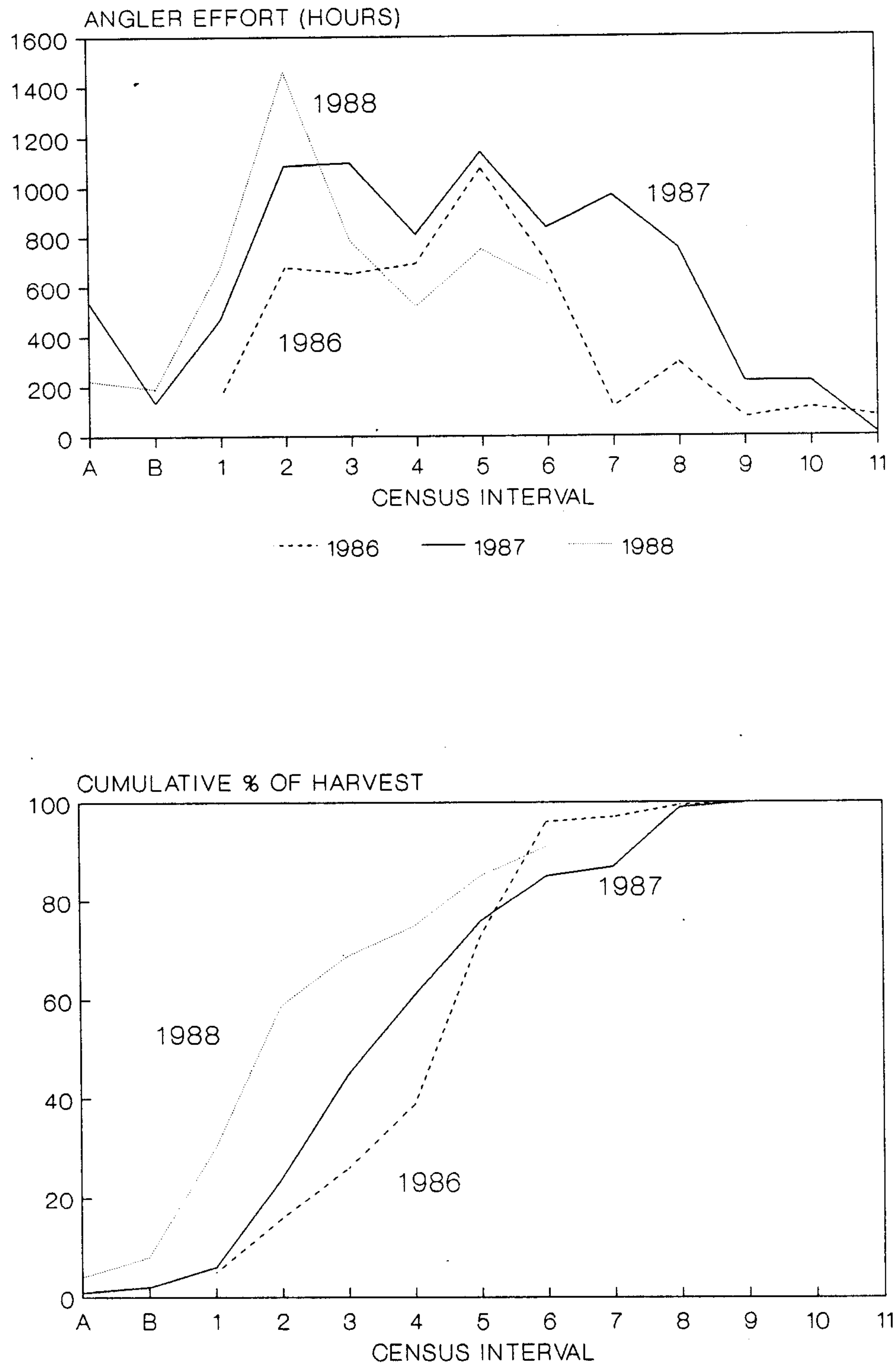


Figure 12. Seasonal distribution of angler effort (top) and cumulative percent of total trout harvest (bottom) for Sections 4 and 7. Sections 4 and 7 were the only sections censused all three years.

Anglers released 66% of the pooled 1986 and 1987 catch (Appendix F). Anglers in the CR area (section 11) were required to released all trout. In the remaining sections, anglers voluntarily released an average of 58% of the catch. More than 70% of the catch in sections 5, 6, 7 and 9 was voluntarily released.

Trout were apparently caught and released multiple times. Within sections 4, 6, and 7, summer densities of wild rainbow trout larger than 100 mm averaged 762 fish/km. Since anglers caught an average of 1,361 (wild trout harvested + released) fish/km, the average wild rainbow trout was caught 1.8 times. We assumed that all released trout were wild fish, if anglers also released hatchery-reared trout, the value for multiple catch of wild trout would be less. Within section 11, summer densities averaged 464 fish/km and anglers released 1,058 fish/km so the average trout was caught 2.3 times. Release of hatchery trout would also reduce this value.

Harvest rates for all trout averaged 0.44 fish/h and ranged from 0.28 to 0.65 fish/h (Appendix F). Rates of harvest were largest in those sections which received the largest introductions of hatchery-reared rainbow trout (Appendix H). Harvest rates generally increased during the initial census intervals, peaked during mid season and declined during the latter intervals (Appendix G).

Anglers harvested an estimated 17,099 trout in 1986 and 1987 pooled (Appendix F). Within sections 4 and 7, estimated harvest increased by 16% from 1986 to 1987. Wild rainbow trout were the predominant fish harvested in five of ten sections and comprized 44% of the total harvest. Harvested wild trout ranged from 160 to 490 mm and averaged 320 mm (Figure 13). Anglers released most wild trout less than 250 mm and selected larger fish.

The temporal distribution of the harvest varied from 1986 to 1988. In 1986, as previously noted, effort and harvest were minimal (16%) prior to July and most (57X) of the harvest occured between July 25 and September 1 (intervals 4-6) (Figure 12). In 1988, more than 60% of the harvest occured prior to July 1. During both years, about 90% of the harvest occured by September 5 (interval 7).

The size structure of wild trout in the harvest also varied temporally as more large trout were harvested early in the season. From 1986 to 1988, an average of 61.4% of the trout harvested prior to July 25 exceeded 300 mm, and 11.8% exceeded 400 mm. Trout harvested during the remainder of the season averaged 36.6% larger than 300 mm and 3.5% larger than 400 mm. Mean total length of trout creeled declined rapidly during the early part of the season and stabilized thereafter (Figure 14). Harvest of large gravid trout contributed to the increased mean total length of fish in the catch during the initial intervals in 1987 and 1988. During both years, anglers captured gravid female trout prior to June 15 (Section 1). Visual surveys of redds and spawning trout and samples of trout in the population verify the presence of gravid females through June 15 (Figure 15).

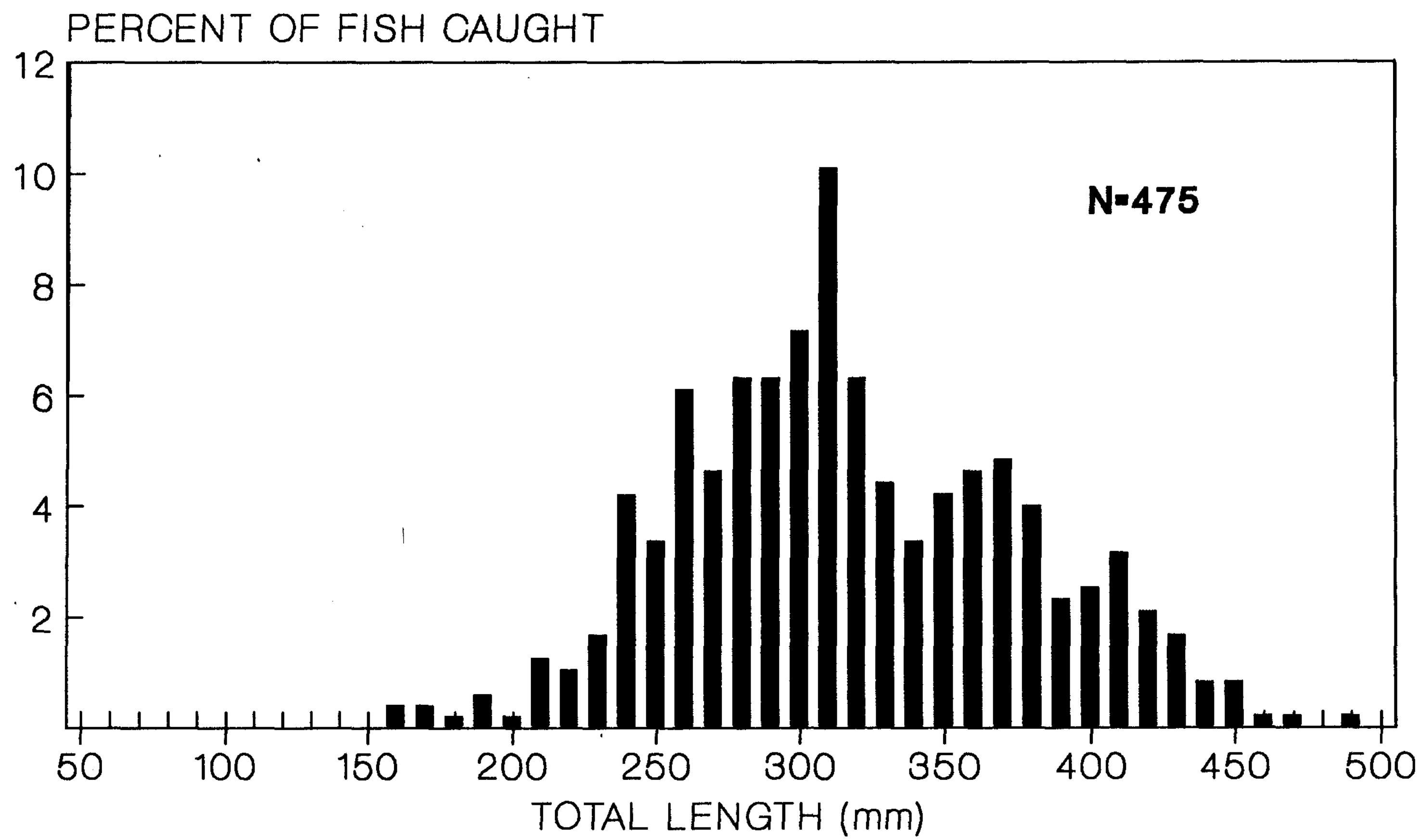


Figure 13. Length-frequency of wild rainbow trout harvested by anglers, 1986-1988.

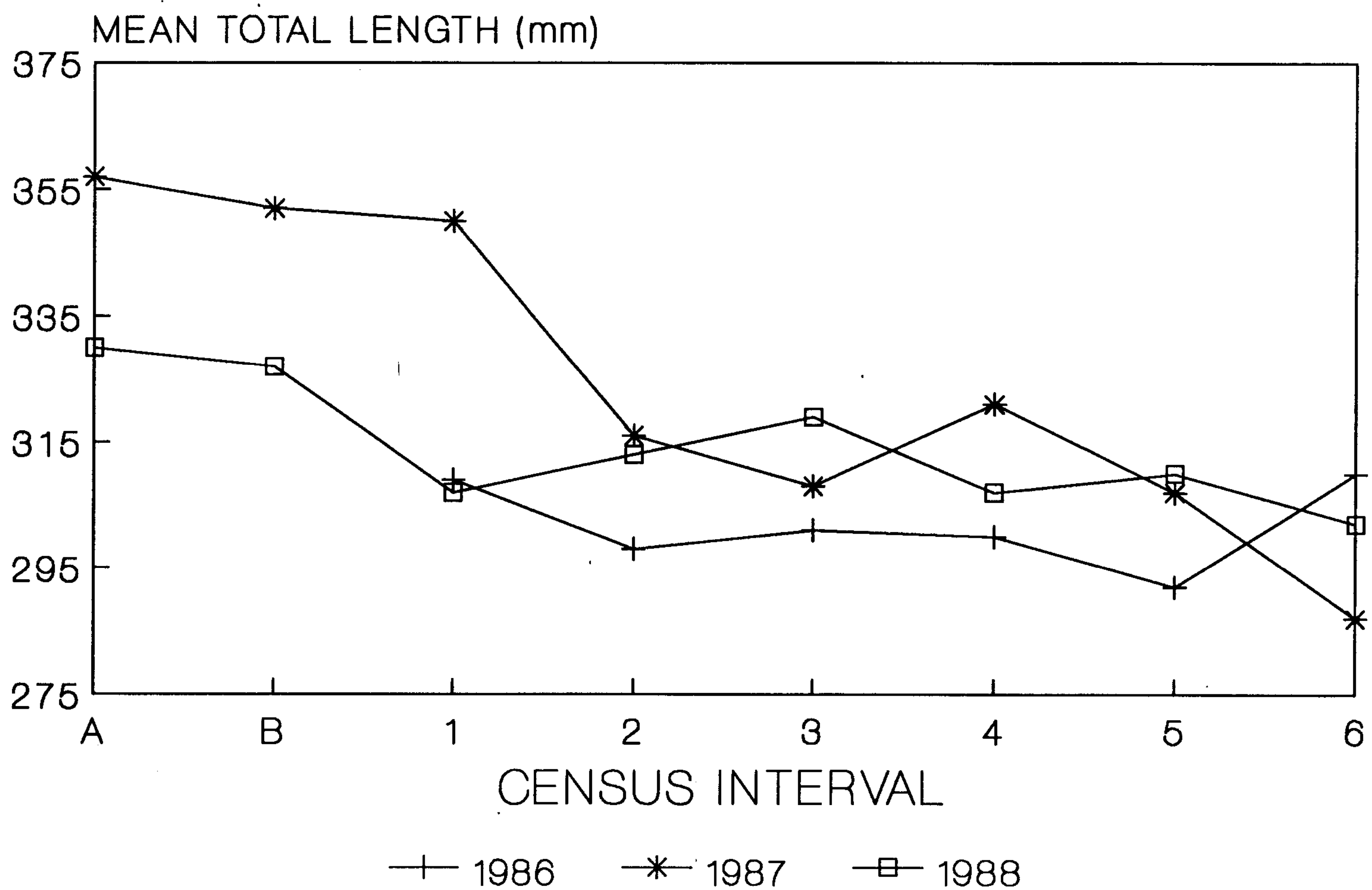


Figure 14. Mean total length of harvested wild rainbow trout by census interval, 1986-1988.

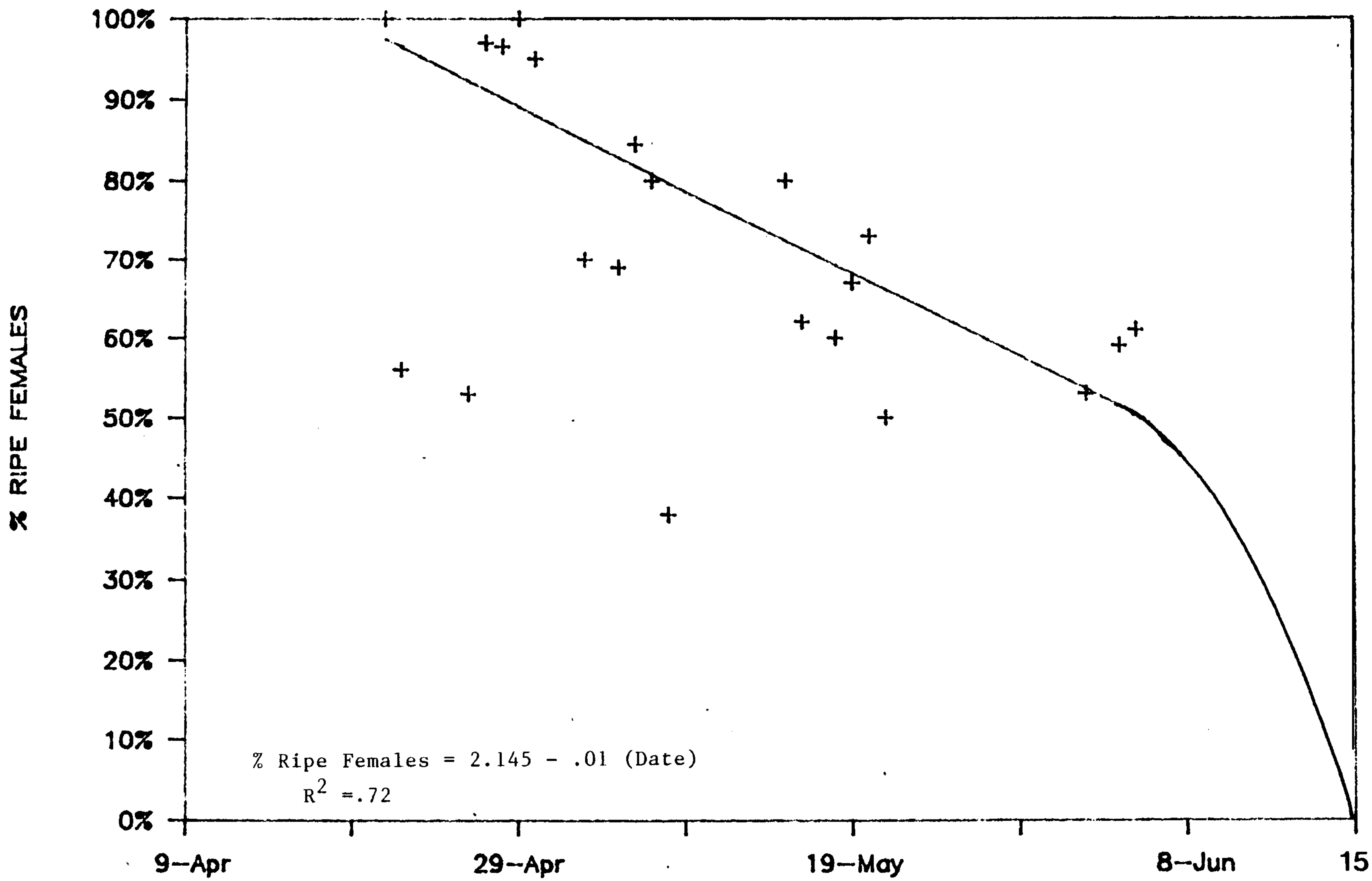


Figure 15. Percent of gravid female wild rainbow trout available, April-June.

Hatchery-reared rainbow trout comprised a majority of the fish harvested in five of ten sections and totaled 52% of the pooled harvest in 1986 and 1987 (Appendix F). Hayspur hatchery personnel estimated that 17,800 and 2,100 hatchery trout were stocked in census sections in 1986 and 1987, respectively. Returns to the creel averaged 48% for both years and varied between sections (Appendix H).

Catch rates were much lower during the winters of 1986 and 1987 than during the general season. Winter catch rates averaged 0.64 fish/h as compared to 1.26 fish/h in summer (Thurow 1987, 1988). Anglers caught 17 fish/km as compared to more than 40 times that rate in summer. Winter anglers harvested an estimated 345 trout from censused sections in 1987. These 345 trout represented an average of 7% of the total (general season + winter) harvest. Wild rainbow trout comprised 88% of the winter harvest as compared to 43% of the summer harvest in the same sections. Winter anglers released 55% of their catch outside the CR area as compared to 58% in summer. Mean size of creeled trout was similar in winter (330 mm) and summer (320 mm).

Exploitation. Exploitation estimates for wild rainbow trout larger than 200 mm ranged from 0.64 to 0.65 within the sections managed under general angling regulations (Table 6). Although the precision of individual estimates was low, replicate estimates were similar among years and sections. Between year variations were not significant.

Exploitation rates were not evenly distributed among size classes. Anglers harvested a disproportionate number of 301-400 mm trout. Trout from 301-400 mm comprized 3.6% of the fish in the population, but 47% of the trout in the angler harvest (Figure 16). With a total exploitation rate of 0.6, exploitation equaled 0.5, 0.8, and 0.6 for trout in 201-300 mm, 301-400 mm, >401 mm size classes, respectively.

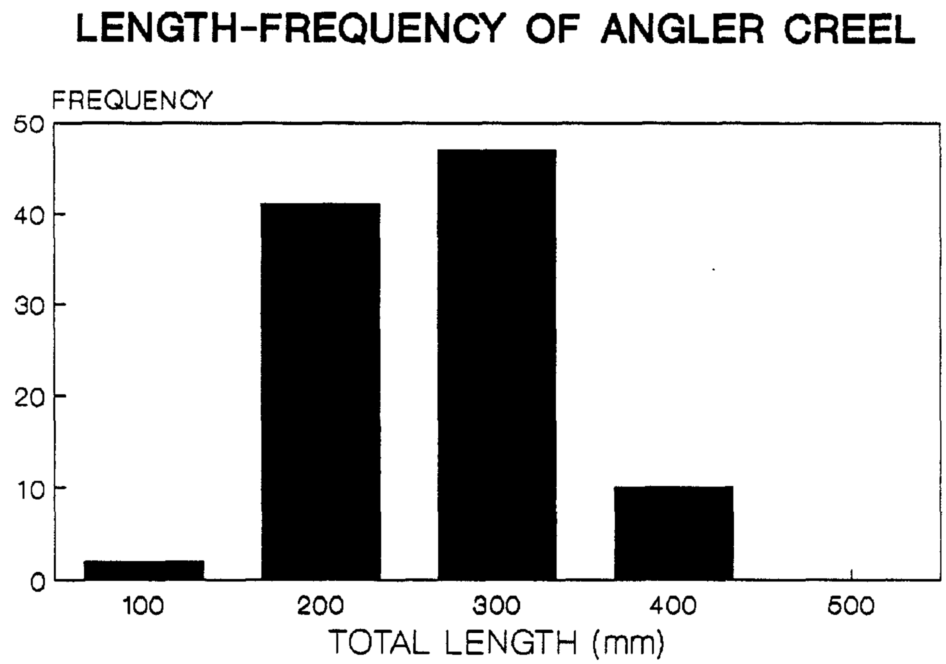
Fishing mortality comprized most of the total mortality in the reaches managed with general angling regulations (Table 7). Within Reach 6 (CR) natural mortality comprized most of the total mortality. Annual mortality rates were large in all reaches and as exploitation decreased, natural mortality rates increased.

Angler Attributes. Resident anglers comprised a majority (67%) of the anglers we interviewed on the river from 1986 to 1988 (Appendix I). Nonresident anglers were most prevalent in the CR area (section 11), where they comprised 66% of the anglers. The proportion of resident anglers increased in sections 4 and 7 from 1986 to 1988.

Anglers using bait comprised 46% of the anglers (excluding section 11 where artificial tackle was mandatory) (Appendix I). Bait anglers were the predominant angler type in five sections. Four of the five sections also received the largest introductions of hatchery trout (Appendix H). Anglers using flies, lures, or multiple tackle comprised the remainder of the anglers. Anglers using flies were most predominant in four sections.

Table 6. Exploitation of wild rainbow trout (>200 mm) calculated from population and harvest data and from the summer to fall change in abundance. Available 95% error bound in parentheses.

Stream reach	Method of calculation		Exploitation	
2,3,4	a) Estimated total harvest divided by population	1986	0.71	(±0.48)
		1987	0.76	(±0.44)
		1988	0.64	(±0.32)
		$\bar{x}$	0.70	
	b) Estimated harvest pre-population estimate + post population estimate divided by population		0.63	
	c) Reduction in population from summer to fall		0.60	
		$\bar{x}$	0.64	
5	a) Same as a) above		0.65	(±0.72)
6	No legal harvest, maximum hooking mortality used		0.10	
7	a) Same as a) above		0.64	(±0.51)



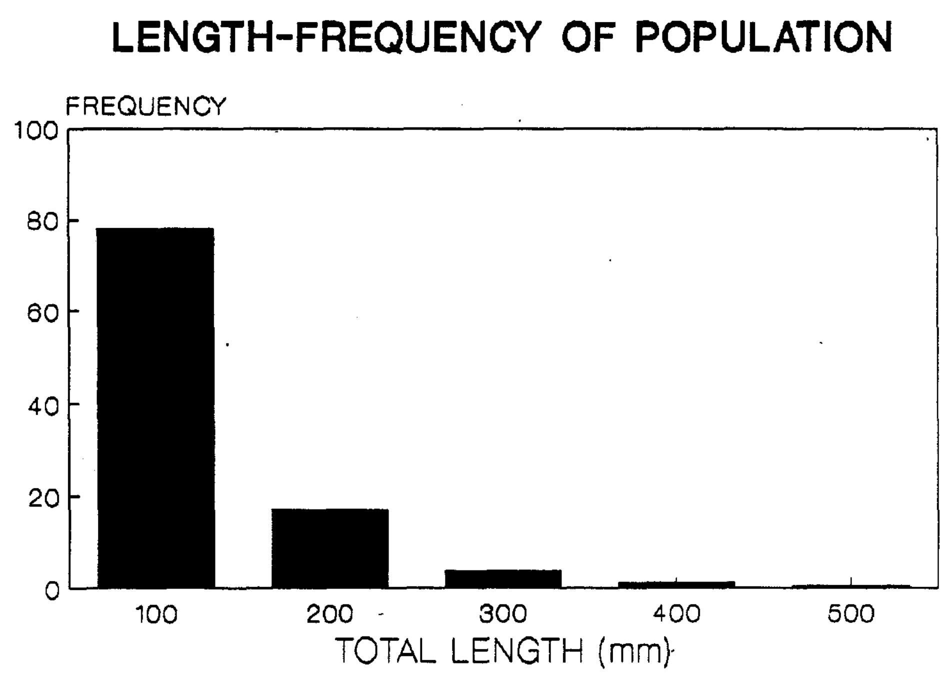


Figure 16. Comparison of wild rainbow trout length-frequencies in the population and angler creels.

Table 7. Estimated instantaneous rates of natural mortality (M), conditioned mortality (U), and fishing mortality (F) using instantaneous mortality (Z), total annual mortality (A), and exploitation (E) (Ricker 1975).

Stream Reach	Regulation	A	M	F	Z	E	U
2,3,4	General	0.75	0.28	1.12	1.40	0.60	0.24
5	General	0.85	0.58	1.90	2.48	0.65	0.44
7	General	0.90	0.67	1.64	2.30	0.64	0.48
6	Catch-and-release	0.65	0.88	0.16	1.04	0.10	0.59

Anglers using flies and lures enjoyed the largest catch rates (Table 8). Fly anglers also released a majority (89-90%) of their catch. Anglers using bait experienced the poorest catch rates and released the smallest percent (26-33%) of their catch. However, bait anglers voluntarily released a substantial portion (38-56%) of their catch in a few sections. Bait anglers caught an average of 35% of the total seasonal catch of wild rainbow trout in sections 1-10 (Appendix J). Fly anglers caught 52% of the total catch.

During the winter fishery in 1986 and 1987, a mean of 92% of the anglers were Idaho residents (Thurow 1987, 1988). The majority (52%) used bait or flies (44%) in the general regulation areas.

Angler Opinions. The statewide angler opinion survey (Reid 1989) documented the significance of the Big Wood River to anglers in Idaho and other western states. Based on angler responses, the river was ranked third behind the Henry's Fork Snake and the Boise rivers as the most popular trout stream fishery in Idaho. Forty-five percent of the respondents were nonresidents, and 52% of the nonresidents were from California.

Results of the statewide survey and our on-stream interviews are difficult to compare. The statewide survey is based upon responses of anglers listing the Big Wood River as their first choice of angling water which may be different than anglers on the stream. However, combining the results provides a cross section of opinions.

Based on streamside interviews, a majority of the anglers fished the Big Wood River less than 10 days annually, considered the fishing good or excellent, and were satisfied with the current size and abundance of trout (Appendix K). A majority of the statewide survey respondents also considered the fishing good or excellent (Appendix L). Although current levels of satisfaction are large, a majority of the anglers in both surveys would support more restrictive regulations to maintain wild trout and provide more large trout. Anglers were supportive of more restrictive regulations regardless of the method they used (Appendix K).

Anglers were also supportive of continued stocking of catchable trout to maintain harvest opportunities in "some sections" of the river (Appendix K). However, a majority of the anglers believed protection and enhancement of wild trout should receive more emphasis, and most favored harvest restrictions over replacement of wild trout with hatchery trout (Appendix L).

Although anglers fished for a variety of reasons, the opportunity to keep fish remained an important factor. Forty percent of the statewide survey respondents would stop fishing their favorite stream if they had to release all fish (Appendix L). The actual percentage may be larger if respondents, already fishing the CR area are segregated. A minority of the anglers responded that a catch rate of keepable size fish was <u>not</u> an important factor in selecting where to fish. Sixty percent of the anglers responded that the chance to catch fish for consumption was at least "somewhat important" as a reason to fish.

Most anglers were supportive of maintaining a consumptive winter fishery for trout (Appendix K).

Table 8. Catch rate, harvest rate (fish/h), and trout released (do) by anglers using various terminal tackle, 1986-1987.

	Harvest rate				Catch. rate				trout			
Section	Bait	Lure	Fly	Multiple	Bait	Lure	Fly	Multiple	Bait	Lure	Fly	Multiple
	1986											
3	0.72	0	0.17	0.10	1.03	0.35	0.98	0.40	30	100	83	75
4	0.79	2.00	0.22	1.00	1.15	5.00	1.98	1.00	31	60	89	0
6	0.42	0	0.18	0.93	0.95	0	1.68	1.20	56	--	89	22
7	0.48	2.50	0.19	--	0.58	4.17	2.17	--	18	40	91	--
8	0.64	0	0.13	--	0.76	0.0	1.56	--	16	--	92	--
10	0.88	0.67	0.08	--	1.06	0.0	1.95	--	17	--	96	--
11	----Catch-and-release---- '				--	--	1.96	--	--	--	100	--
12	0.85	2.00	0.13	0.71	0.98	0	0.38	0.71	14	_ --	67	0
Total[a]	0.68	0.54	0.16	0.55	0.93	1.14•	1.49	0.75	26	53	89	26
	1987											
1	0.58	0.14	0.10	0.39	0.94	0.56	1.10	1.59	38	75	91	75
4	0.73	0.59	0.06	0.68	0.87	2.10	1.34	1.25	16	72	96	46
5	0.94	0.52	0.12	0.41	1.02	1.74	1.24	0.96	8	70	90	57
7	0.38	0.47	0.18	0.00	0.68	2.23	1.37	0.11	44	79	87	100
11	----Catch-and-release----				--	2.86	1.77	--	--	100	100	--
Total-	0.61	0.39	0.14	0.49	0.91	1.43	1.34	1.24	33	73	90	63

[a]Excluding Section 11.

***Population* Simulations For Wild Rainbow Trout**

As a result of differences in growth and mortality, results of population simulations are segregated into lower (below Warm Springs Cr.) and Upper (above Warm Springs Cr.) areas. Unless otherwise stated, all results are from simulations without bait.

Lower River

Size Limits. As exploitation increased, the percent of large (>300, >400 mm) trout in the population declined (Figure 17). At existing levels of exploitaton, (0.6 to 0.7) most of the regulations provided an increase in the percent of large trout by reducing the harvest (Figure 18, Appendix M). Minimum size limits of 254 mm and 305 mm failed to increase the percent of trout larger than 400 mm. A 406 mm size limit produced a dramatic increase in large trout, but reduced harvest by 57%. With the exception of the 406 mm size limit, the regulations had a minor impact on the abundance of trout.

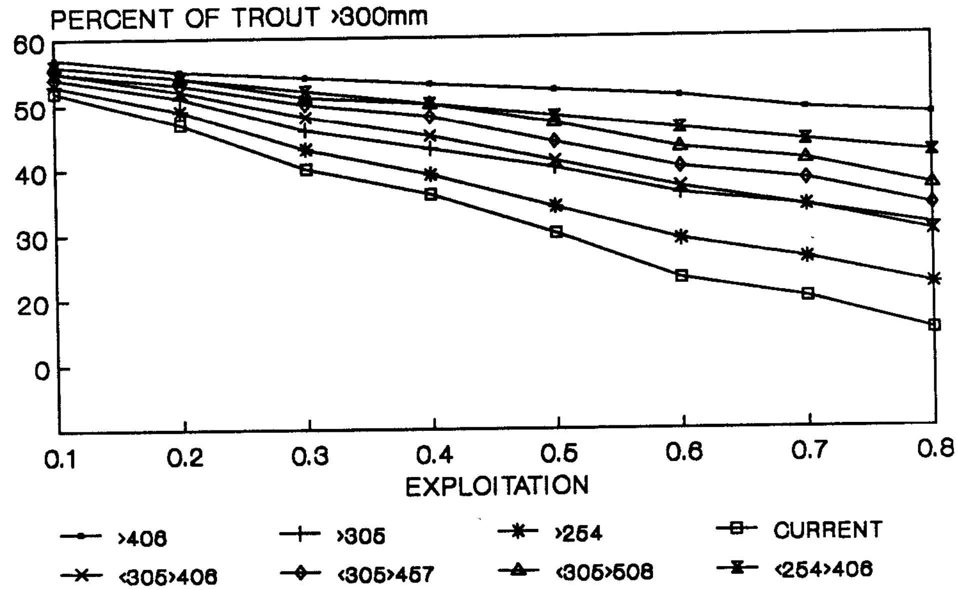
The winter harvest of wild rainbow trout had a minor influence on the population responses to various regulations. The current winter fishery represents 7% of the total (summer + winter) harvest. Because some size classes are exploited disproportionately, a 7% increase in harvest represents a 5% increase in exploitation. The slopes of the predicted response lines tend to flatten (Figure 17) at higher exploitation rates, and a 5% increase in exploitation (from 60% to 65%) has a minor effect.

Bag Limits. Because only 15% of the anglers on the river harvest two or more trout, a bag limit had a minor influence on total harvest unless it was reduced to less than 2 fish (Figure 19). A 2-fish bag limit, without a size limit, increased the percent of trout (>300, >400 mm) from 23% to 31% and from 4% to 10%, respectively at existing exploitation levels.

Hooking Mortality. At a maximum hooking mortality rate of 60% on trout caught with bait and released, all regulations except the 254 mm and 305 mm minimum size limits increased the percent of large trout (Appendix M). The most restrictive regulations, which required the release of a majority of the catch, substantially increased the loss of fish as a result of hooking mortality (Appendix N).

Combining a 2-fish bag limit with the size limits improved the response in the population structure. The bag limit compensated for some hooking mortality and increased the percent of large trout (Figure 20).

Compensatory Mortality. Estimates of mortality suggest that annual mortality rates in the Big Wood River are large and compensatory mortality may be occurring. As exploitation rates decrease, natural mortality appears to increase (Figure 4).



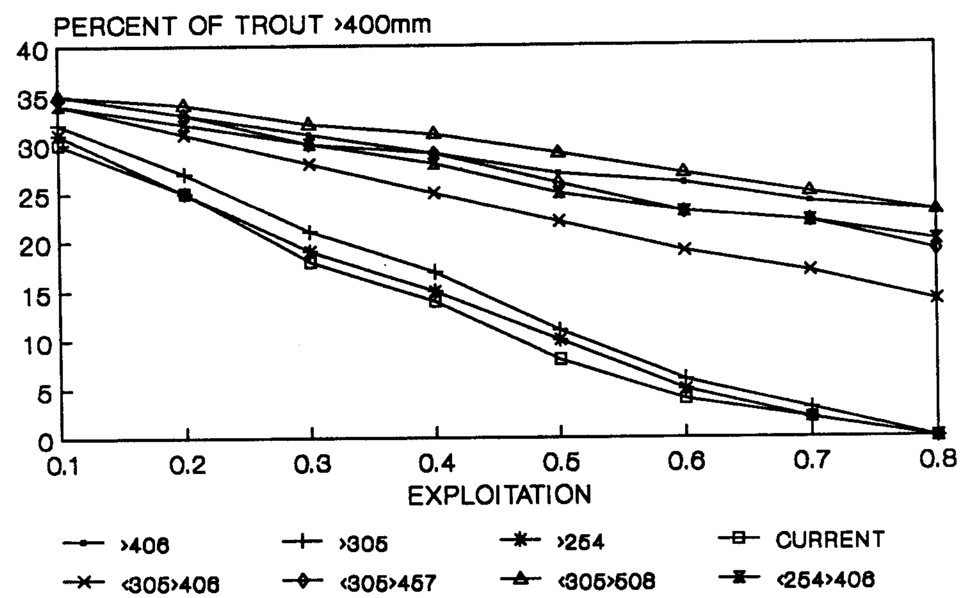


Figure 17. The estimated percent of wild rainbow trout (>300, >400 mm) with varying levels of exploitation and size limits, lower Big Wood River. Simulations are without bait.

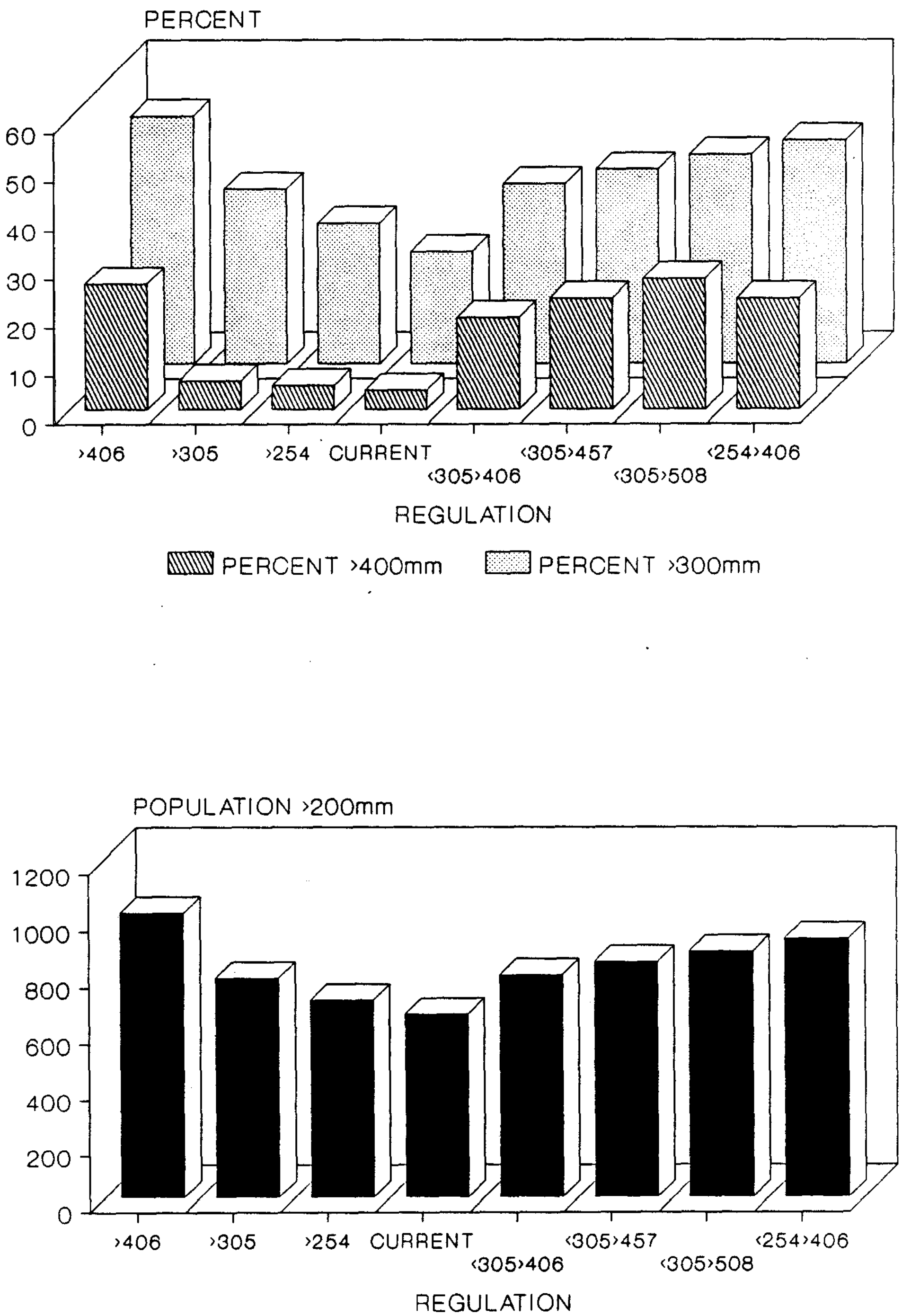


Figure 18. The estimated percent of wild rainbow trout (>300, >400 mm) (top) and the number of trout (>200 mm) (bottom) with varying size limits at current exploitation, lower Big Wood River. Simulations are without bait.

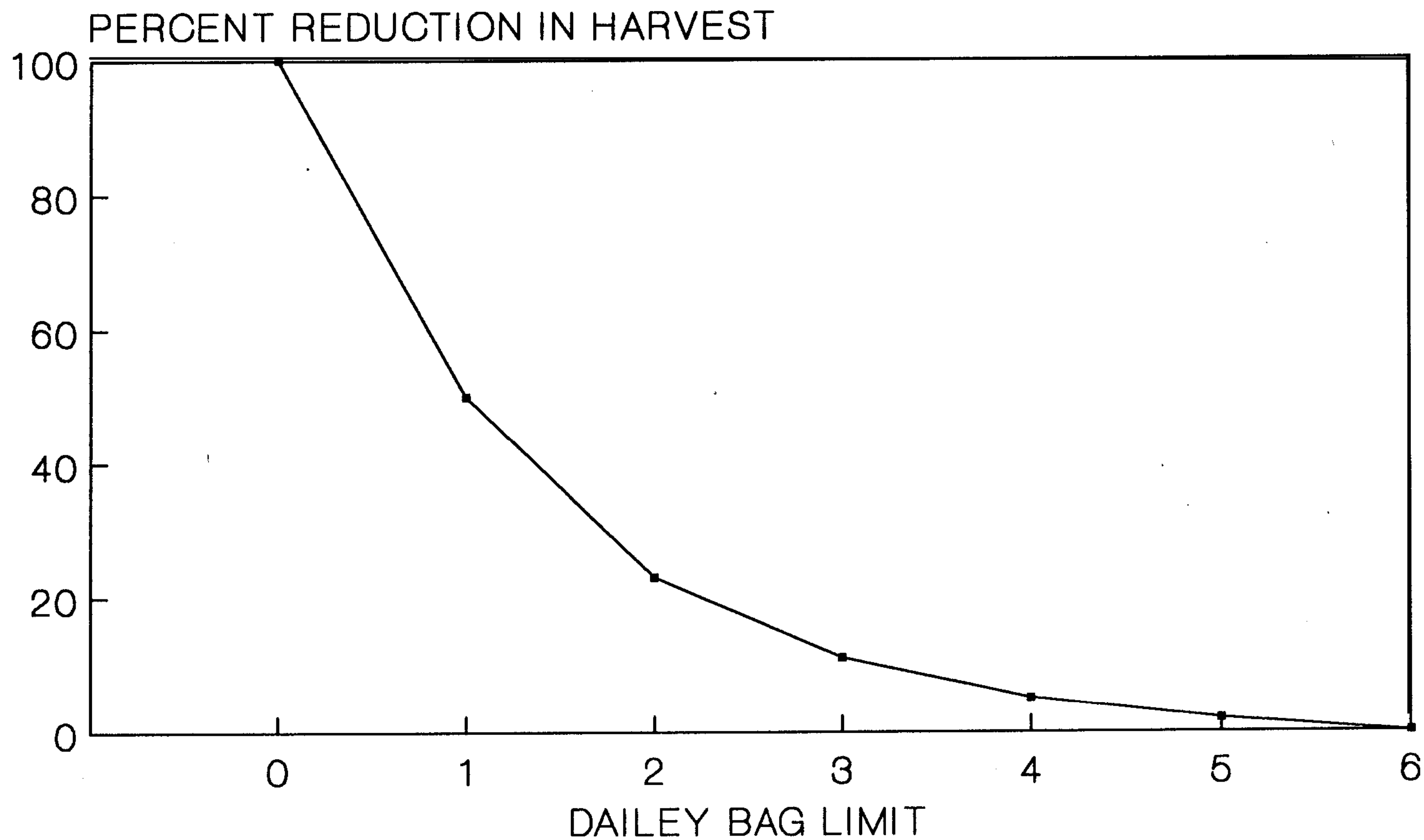
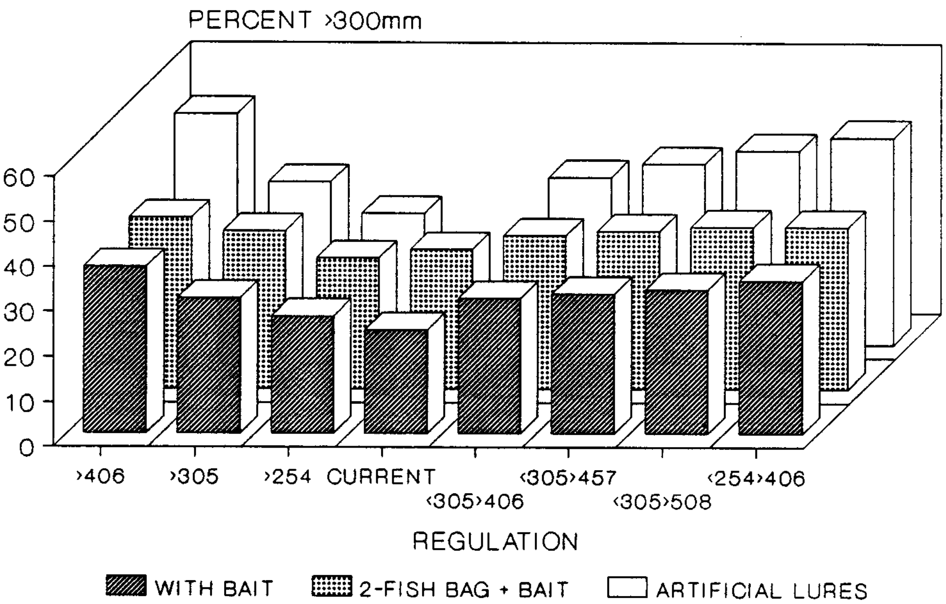


Figure 19. The percent reduction in total harvest of wild rainbow trout with different daily bag limits.



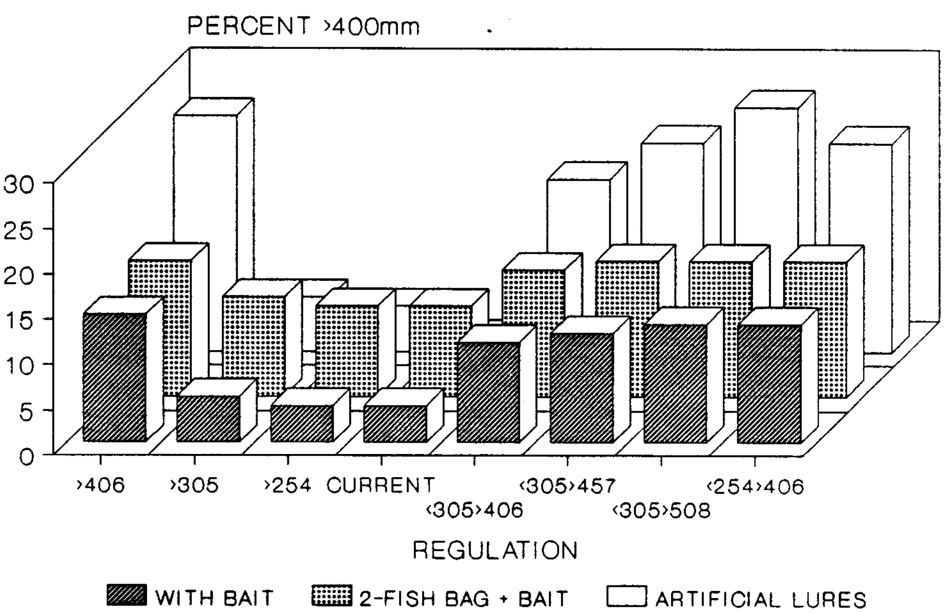


Figure 20. The estimated percent of wild rainbow trout (>300, >400 mm) with varying size limits with bait, a two-fish bag with bait, and artificial lures at current exploitation, lower Big Wood River.

At current levels of exploitation, the population responses to varying levels of conditional mortality do not differ from responses with constant mortality (Figure 21). However, the effect of compensatory mortality is magnified for regulations which severely reduce exploitation. For example, with constant mortality, a catch-and-release regulation results in a predicted percent of trout >400 mm of 30%. With compensatory mortality, the percent of trout >400 mm equals 18%.

Upper River

Size Limits. Population variables displayed a relationship to exploitation. However, as a result of slower growth and higher mortality rates in the upper river, the influence of a change in exploitation was much less than in the lower river (Figure 22). Most of the regulations had a minor effect on harvest and produced similar population responses. Total abundance was nearly unaffected by the regulations tested (Figure 23, Appendix M).

Bag Limits. Bag limits of less than 2-fish had a minor effect on population variables (Figure 19). A 2-fish bag limit without a size limit increased the percent of trout (>300, >400 mm) from 9% to 13% and from 0.5% to 1%, respectively, at existing exploitation levels.

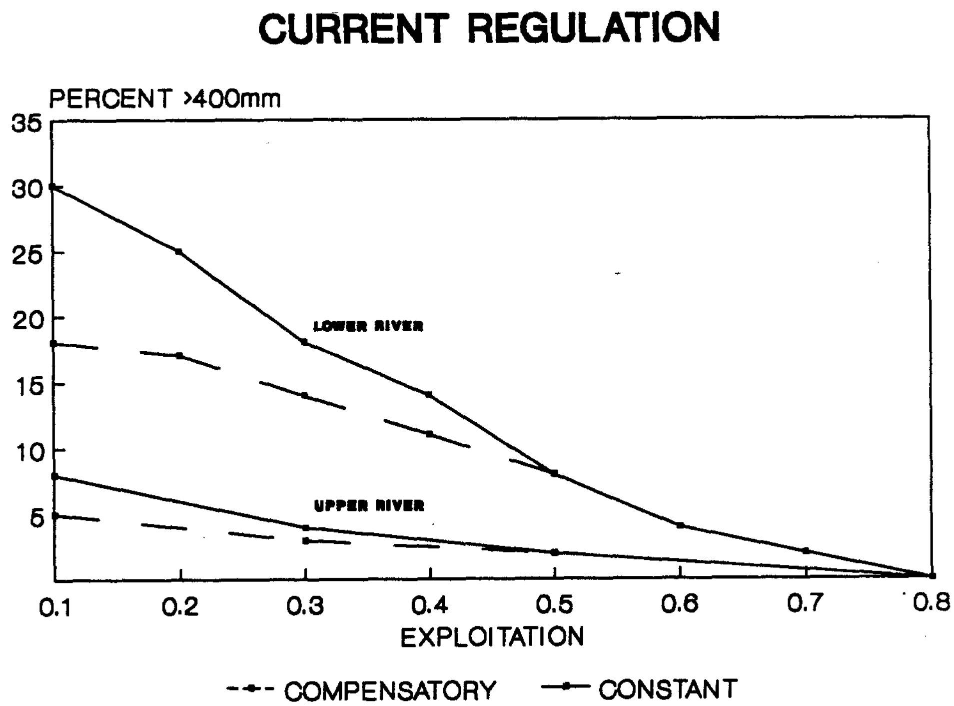
Hooking Mortality. At a maximum hooking mortality rate of 60% on trout caught and released with bait, most regulations did not substantially increase the percent of large trout (Appendix M). However, as we observed in the lower river, the combination of a size limit with a 2-fish bag limit improved the population response over that without a bag limit.

Compensatory Mortality. As we observed in the lower river simulations, the influence of compensatory mortality was largest for the most restrictive regulations (Figure 21). With constant mortality, a CR regulation resulted in percentages of trout (>300, >400 mm) of 31% and 11%, respectively. With compensatory mortality, percentages of trout declined to 25% and 6%, respectively. The population structure with compensatory mortality is nearly identical to the existing population structure in the CR area where the percentages of trout (>300, >400 mm) equal 26% and 4%, respectively (Table 3).

Status Of Other Game Fish

The following section briefly describes the distribution, abundance, size composition, movements, and angler harvest of game fish including brook, brown, cutthroat and hatchery-reared rainbow trout, and mountain whitefish.

Brook trout were present in small numbers in all seven electrofished reaches. Brook trout comprized approximately 2% of the trout sampled from 1986 to 1988 (Thurow 1987, 1988). A 1987 sample of



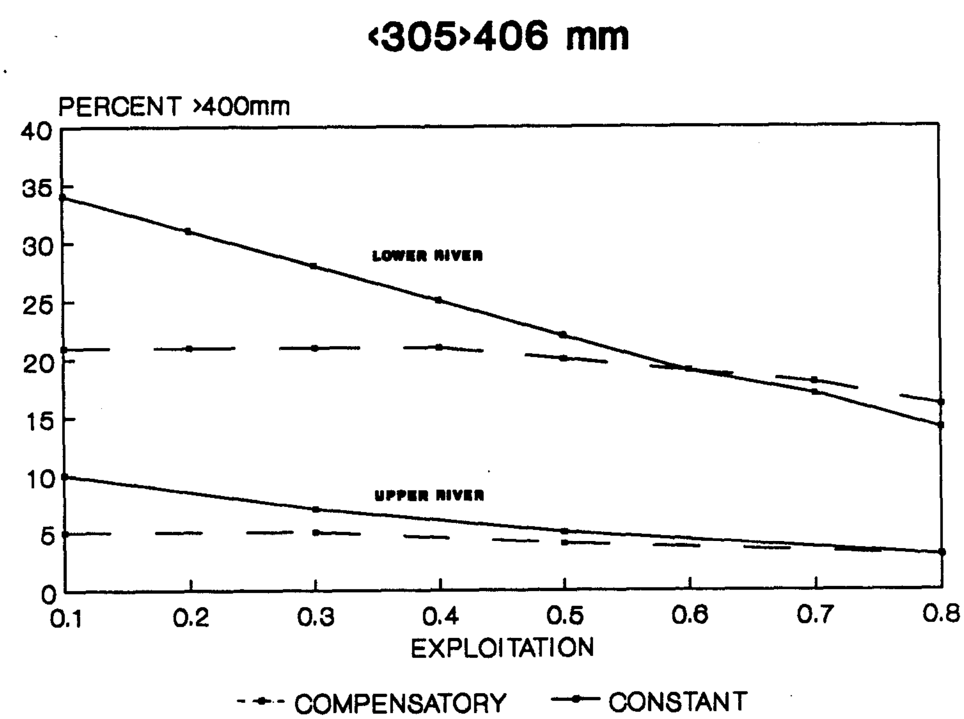
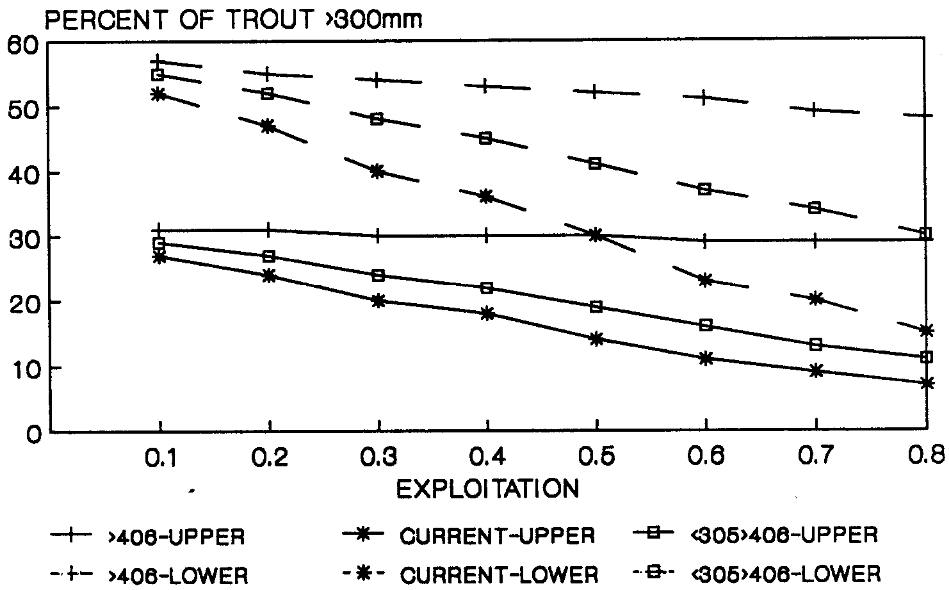


Figure 21. The estimated percent of wild rainbow trout (>400 mm) with varying levels of exploitation with constant and compensatory mortality, upper and lower Big Wood River. Simulations are without bait.



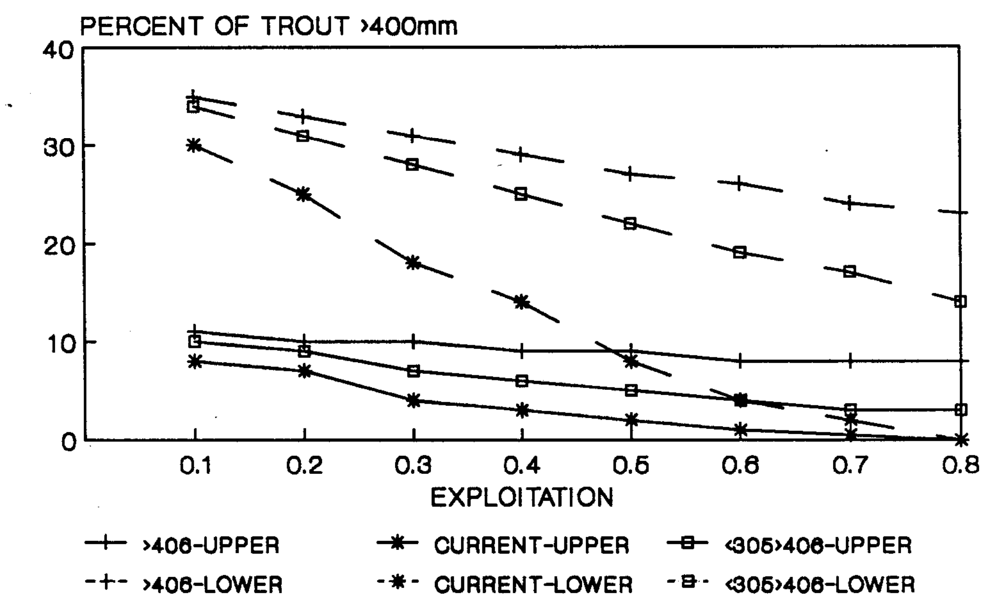
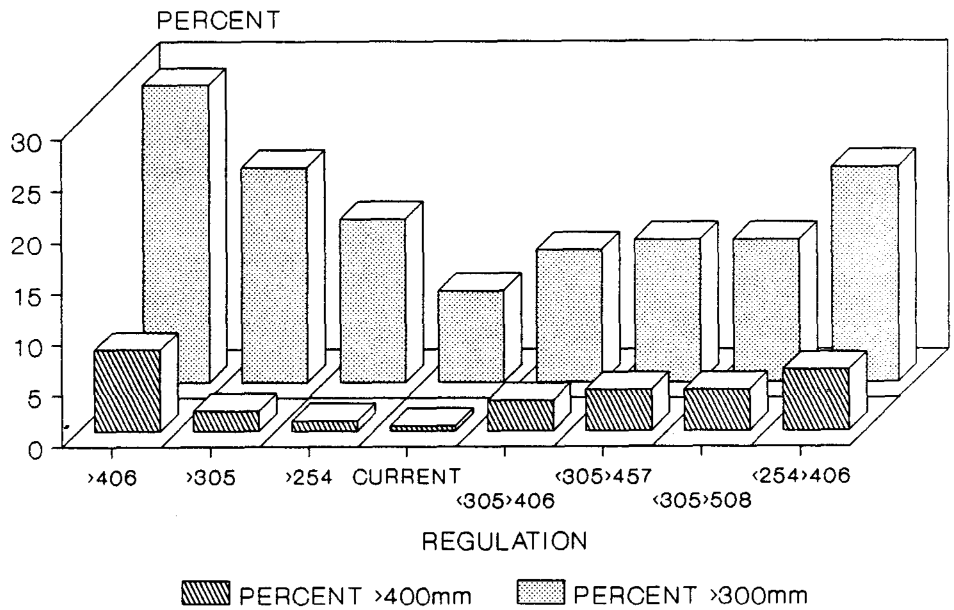


Figure 22. The estimated percent of wild rainbow trout (>300, >400 mm) with varying levels of exploitation and size limits, upper and lower Big Wood River. Simulations are without bait.



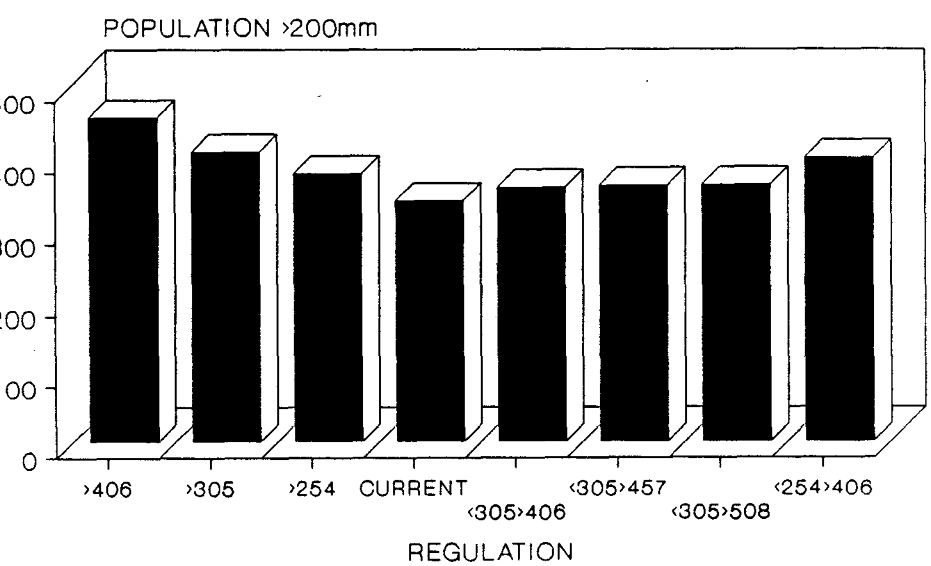


Figure 23. The estimated percent of wild rainbow trout (>300, >400 mm) (top) and the number of trout/km (>200 mm) (bottom) with varying size limits at current exploitation, upper Big Wood River. Simulations are without bait.

66 brook trout averaged 191 mm and ranged from 60 to 390 mm. Few brook trout exceeded 250 mm. Thurow (1987) describes the length-weight relationship for brook trout. We did not recover sufficient numbers of tagged trout to assess movements. As a result of their low abundance, anglers harvested few brook trout. In 1986 and 1987, brook trout comprized less than 1% of the trout creeled. Brook trout exceeding 300 mm were formerly common in several of the springs tributary to the Big Wood River between Bellevue and Ketchum prior to the residential development of those areas (S. Gebhards, Idaho Department of Fish and Game, personal communication).

Brown trout were common in reaches of the Big Wood River downstream from the Glendale Diversion. Brown trout originally entered the river as a result of illegal introductions. In the early 1970's, conservation officers and biologists observed hatchery-reared brown trout with eroded dorsal fins, from an unknown source in the river near Ketchum (B. Bell, Idaho Department of Fish and Game, personal communication). By 1980, brown trout were established in Magic Reservoir and the river immediately upstream from the reservoir but were not established in the river above the Glendale Diversion. From 1986 to 1988, we observed only one brown trout in the river above the diversion.

Mature brown trout migrate from the reservoir and lower river to spawn in an 11 km reach of the river downstream from the Baseline Bypass Canal. The canal effectively blocks movements above that point. In July 1986, brown trout comprized 1% of the trout in Reach 1. As a result of the spawning migration, the percentage of brown trout increased to 38% by October 24 (Thurow 1987). A weir was installed in 1987, and brown trout entered the weir on October 4 and spawning commenced after October 10 (Thorpe 1988).

Similar numbers of brown trout spawned in the reach from 1986 to 1988. We observed 122, 196, and 158 redds in 1986, 1987, and 1988, respectively, for a mean of 159 redds per year. Spawning was completed by November 20 each year.

Mature brown trout were large and most exceeded 400 mm. Forty two brown trout were electrofished in 1986 and 60% and 26% exceeded 400 mm and 500 mm, respectively (Thurow 1987). In 1987, 98 brown trout entered the weir and 92% and 52% exceeded 400 mm and 500 mm, respectively (Thorpe 1988). Thurow (1987) describes the length-weight relationship for brown trout.

After spawning, most mature brown trout migrated to Magic Reservoir. We recovered 15 trout originally tagged in the river and only one was recovered there. The remaining 14 trout were recovered in the reservoir (9 trout) or in the river below the reservoir (5 trout). As a result of reservoir drawdown, more trout may have migrated through the dam in 1987 and 1988 than during years with normal flows.

We were unable to determine where the progeny of spawning brown trout rear. During electrofishing surveys, we captured only five brown trout less than 200 mm. Juvenile brown trout may rear in springs tributary to the river, in lower reaches of the river immediately above the reservoir, or in the reservoir.

Brown trout were available to and popular with anglers in the Big Wood River. In 1986, brown trout comprized 25% of the trout creeled in section 1 (Thurow 1987). Anglers harvested 12% of the trout tagged in 1986 and 10% of the trout tagged in 1987 within one year of release. A majority of the anglers polled in the section supported the increasing brown trout population (Thurow 1988).

Cutthroat trout were uncommon in the Big Wood River. We observed less than 10 cutthroat trout during electrofishing and creel surveys from 1986 to 1988. We believe the cutthroat trout we observed were the result -of movements of trout from mountain lakes in the drainage.

The abundance of hatchery-reared catchable-sized rainbow trout (catchables) varied as a result of stocking density and frequency. Most catchables introduced to the Big Wood River are of a fall spawning Hayspur hatchery stock. In 1986 and 1987, catchables comprized 15% of the trout captured by electrofishing. Most catchables either succumed to natural mortality or migrated out of the stocking sections. Some catchables survived the winter, and we captured 15 and 23 catchables during spring surveys in 1986 and 1987, respectively.

Hatchery trout exhibited downstream movements from the stocking location. We recovered 30 of 200 jaw tagged trout, most (90%) within 21 days of the August 23, 1987 release date (Thurow 1988). Ten trout moved more than 1 km, and 9 of 10 trout migrated downstream. One trout moved more than 11 km by October 12.

Catchables comprized a majority (52X) of the trout harvested by anglers in 1986 and 1987 (Thurow 1988). Most anglers were supportive of the continued stocking of catchables in "some sections" of the Big Wood River, regardless of their preferred terminal tackle.

Mountain whitefish were present in all reaches of the river, and most abundant in Reaches 2 and 7. A 1986 sample of 553 whitefish averaged 258 mm and ranged from 70 to 480 mm (Thurow 1987). Five potential age classes were suggested in the length-frequency.

Few anglers harvested whitefish in the Big Wood River. We rarely observed whitefish in the creel during the summer. During the winter seasons in 1986 and 1987, whitefish comprized 40% of the game fish we observed in the creel. This value is misleading, however, because one angler accounted for more than 60% of the whitefish we observed.

DISCUSSION

Implications For Angling Regulations

The Big Wood River drainage currently supports a self sustaining population of wild rainbow trout and a substantial sport fishery. Although the current fishery is good to excellent (catch rates exceeding one fish per hour, >50% of the harvest exceeding 300 mm), this sport fishery will not be maintained without an integrated management plan designed to protect and restore habitat and adequately control harvest. As previously noted, alternatives for habitat management will be addressed in a separate report. Successful responses to regulations discussed in this report are based on the premise that current habitat quality will be improved or maintained.

Optimum angling regulations should be based on the biological capabilities of the system and the social preferences of its anglers. As Lewynsky (1986) observed, successful programs adapt the capabilities of the resource to the desire of anglers. Controversies are often created when anglers have an inadequate appreciation of the limitations of the resource and it is the biologists role to foster realistic expectations (White 1977). Sociological information is required to help allocate finite resouces among competing user groups and to understand the impact of management decisions on resource users (Orbach 1980). Management goals should reflect these biological and social constraints. Goals must also be stated explicitly so the success of the program may subsequently be evaluated.

The biological capabilities of the Big Wood River vary spacially. Four biological units exist. The first unit, Magic Reservoir to the Glendale diversion, is severely limited by withdrawl of water from the channel for irrigation. During a typical year, the sport fishery targets fish migrating through the reach early in the season and declines after July as a result of reduced flows which limit trout abundance. During low flow periods, many of the trout in the reach apparently migrate to the river immediately above the reservoir or into the reservoir. Unless stable flows can be secured, this unit cannot be expected to respond to regulations.

The second unit, Glendale diversion to Warm Springs Creek, supports a viable wild trout population with rapid growth rates and the potential to attain sizes exceeding 500 mm. Severe habitat alterations and withdrawl of water limit the trout population in a reach between the Glendale diversion and Star bridge. Above Star bridge, although natural mortality rates are large, angler exploitation appears to comprise the bulk of the annual mortality on age II and older trout. Based on the simulations, a variety of regulations could be applied to produce a positive response in the proportion of large trout in the population. Trout in that portion of the unit above Star bridge could be expected to respond to regulations designed to reduce angling exploitation and/or transfer it to size groups capable of withstanding more exploitation.

Warm Springs Creek to the North Fork comprises the third unit, and supports a viable wild trout population with slower growth rates than the lower units, but with the capability to attain sizes exceeding 400 mm. This unit contains a reach of stream currently managed as a CR water. Estimated natural mortality rates were very high in this unit. As reflected in the differences in size structure between the CR and general regulation area, angler exploitation effects the size structure of the population. Based on the simulations, a variety of angling regulations could be applied to produce a positive response in the size structure of the currently exploited population. However, this unit has a smaller potential to support large trout and cannot be expected to respond as well as the second unit. Results of the simulations illustrate the profound influence that reduced growth rates and higher natural mortality rates have on the population responses to various regulations.

The fourth unit, upstream from the North Fork, supports a small population of wild trout. Growth rates were not evaluated, but I believe they are similar to or lower than rates in the third unit. Summer densities were low and natural mortality rates very high in this unit. Although angler exploitation effects the population, as a result of the small standing stock, natural recruitment is probably inadequate to sustain an intensive consumptive fishery without very restrictive regulations. Restrictive regulations should not be expected to produce large numbers of large trout in this unit.

Biological factors alone cannot define optimum regulations, they merely place constraints upon the magnitude of the fish population response (Clark et. al. 1981). Sociological factors will assist in selecting areas best suited to meet angler preferences and produce the desired biological response. Angler types were segregated spacially in the Big Wood River based on their behavior, attitudes, and preferences. Bait anglers were the predominant angler type in all of Unit 1; those portions of Unit 2 between Hailey and the Glendale Diversion and near the KOA campground; that portion of Unit 3 outside the CR area; and in all of Unit 4. Fly and lure anglers were most prevalent in portions of Unit 2 between Hailey and Cold Springs and North of the KOA; and in the mandatory CR reach of Unit 3. A majority of the anglers in all units supported more restrictive regulations to increase the size of trout, regardless of their preferred angling method.

The trout population in some units of the Big Wood River has the potential to respond to more restrictive regulations and increase the opportunity to catch large (>300 mm) wild trout. Where habitat is sufficient, the river can be managed for a wild, self sustaining trout population. Anglers currently effect the size structure of the population by exploiting larger size classes disproportionately. Simulations suggest that the proportion of large trout will increase if regulations which reduce exploitation are implemented. Restrictive regulations cannot be expected to increase the total abundance of trout, however. Trout density is related to the amount and quality of available habitat (White and Brynildson 1967; McFadden 1969). Most regulations tested had a minor impact on total population abundance. Observed natural fluctuations in population abundance were larger than predicted responses from the most restrictive regulations.

Restrictive regulations on the Big Wood River may be socially acceptable as well as biologically useful. A majority of all anglers, regardless of their preferred method, support more restrictive regulations designed to increase the abundance of large trout. Many anglers voluntarily release a large proportion of their catch.

Our simulations also suggest that goals to increase the abundance of large trout are compatable with goals to maintain diverse angling experiences. Results of our on-stream interviews and the statewide survey illustrate that the Big Wood River currently supports a very diverse group of anglers. As Jackson (1988) reported, people who fish for trout may have the broadest range of individual differences of any angling sub-group. Good management thus implies providing a range of angling experiences for these diverse clientele (Voiland and Duttweiler 1984; Wells 1984; Peyton 1987; Jackson 1988). Because of the large proportion of bait anglers on the river, attempts to displace this segment will be met with opposition and potential non-compliance to new regulations. Based on his experience on the Coeur D'Alene River, Lewynsky (1986) observed that where a majority or large minority of anglers oppose a regulation, use will either decrease substantially, or if no change in the user group occurs, non-compliance will be high and difficult or impossible to control. In 1986 the Washington Department of Wildlife implemented a controversial strategy which prohibited bait in approximately 80 streams (Anonymous 1988). A compliance survey in 1988 found a 23-28% rate of noncompliance, and compliance of less than 90% on 67% of the streams. Although most anglers complied with size and bag limits, 80% of the violations were for using bait.

If goals to increase large wild trout and maintain angler diversity are desirable, the following criteria can be established to select the best regulation to meet these goals.
Regulations should:

1. Provide a desired percentage of large trout (>300, >400 mm). An objective of 35% >300 mm and 15% >400 mm was proposed by management. Based on our simulations, this is a feasible goal for the lower river only. The upper river has less potential and an appropriate goal might approximate 15% >300 mm and 3% >400 mm.

2. Displace as few anglers as possible.

3. Minimize hooking mortality.

Size limits are the most effective regulations to meet management objectives. As Hunt (1970) observed, size limits are effective because they apply to every trout caught and are related to growth rates. Size limits coupled with a bag limit of two fish met management objectives on the Big Wood River. Because most (85%) of the anglers on the Big Wood River harvest less than two fish, a reduced bag limit of two fish alone would not meet management objectives. A reduced bag limit of one fish may be unacceptable to anglers who wish to havest some trout. Within lower river reaches, slotted size limits requiring the release of all trout from 305-406 mm or from 305-457 mm, coupled with a 2-fish bag limit, provided a size structure equal to the objective and retained all angler types (Appendix M). Within the upper river, all three slot limits allowing harvest of trout less than 305 mm, coupled with a 2-fish bag limit, met the proposed criteria. These regulations functioned as a 305 mm maximum size limit as a result of the small numbers of trout exceeding 406, 457, and 508 mm.

Traditionally, where size limits are implemeted and a large proportion of the catch is released, tackle is limited to artificial flies and lures only. Gear limitations are based on literature which illustrate that hooking mortality is reduced when tackle is limited to artificial flies and lures (Mongillo 1984). Our simulations suggest that even with a maximum hooking mortality rate of 60%, management goals for increasing large wild trout can be attained without prohibiting bait. Size limits without gear restrictions have been used successfully in other trout waters. In Idaho's South Fork Snake River, a <254 >406 mm slot limit has resulted in an 80% increase in cutthroat trout abundance and a four-fold increase in the percent of trout larger than 406 mm (Thurow et. al. 1988). Turner (1986) reported the successful use of a 380 mm minimum size limit on Missouri's North Fork White River, where approximately 37% of the anglers used bait. After six years, both catch rates and the fall abundance of trout more than doubled. In Pennsylvania, a CR regulation was implemented on Spring Creek, where fish were unsafe for consumption as a result of chemical contamination. Bait was not prohibited and age I and older brown trout increased from 286 to 700 fish/hectare since 1982 (M. Marcinko, Pennsylvania Fish Commission, personal communication). Actual mortality of trout caught with bait and released is probably less than the 60% value we modeled. The existing literature suggests that an average of 25% of the trout caught with bait and released, die (Wydoski 1977; Mongillo 1984). Turner (1986) estimated the mortality of trout caught and released under a regulation which did not prohibit bait. Mortality ranged from 9% in 1982 to 20% in 1986. As Lewynsky (1986) observed, mortality of trout hooked with bait is not due to bait per se, but to the depth and location of hooking. Hulbert and Engstrom-Heg (1980) documented hooking mortality of less than 1% for trout hooked in the jaw or roof of the mouth with bait. Hunt (1970) observed that mortality of bait hooked trout could be substantially reduced if anglers could be educated to cut their lines and release deeply hooked fish. A majority (70-80%) of deeply hooked trout would survive if lines were cut and hooks were left in the fish (Mason and Hunt 1967; Hulbert and Engstrom-Heg 1980). A media campaign with promotions, such as a free hook give-away to bait anglers (D. Schill, Idaho Department of Fish and Game, personal communication), could be used to reduce bait hooking mortality and increase the response of the trout population to size limits.

Additional research is needed to determine if mortality of trout caught with bait can be reduced. Variables, including bait type, hook size, and method of bait presentation could be tested. Measures to increase the proportion of trout hooked in non-lethal locations with bait would reduce the need for bait prohibitions. The successful use of size limits with bait would have wide application in increasing the size structure of trout populations regardless of the proportion of bait anglers. As Lewynsky (1986) observed, the use of special regulations without bait prohibitions may also increase angler acceptance of restrictive regulations.

To simplify the regulations for the public and to reduce potential enforcement problems, it would be preferable to consider implementing uniform regulations on the largest sections of the Big Wood River possible. If special interest groups express a desire for stream segments which are restricted to specific angling types (ie. catch and release, artificial lures only), and the majority of the public supports this goal, a suitable area could be zoned to provide such a segment. A suitable area may be a reach which has the potential to maximize the biological response and currently sustains a majority of anglers who use artificial tackle. The stream segment between the East Fork and Red Top Meadows is suitable as such a segment. The potential biological responses are large, a CR regulation limited to artificial tackle could maximize the response of the population and result in percentages of large trout (>300, >400 mm) of 44% and 18%, respectively. The current CR area in Unit 3 should be scrutinized. Considering the large natural mortality rates in the reach, it may be acceptable to increase exploitation of certain size classes which currently succumb to natural mortality.

If general regulations continue on the Big Wood River fishery managers could perhaps distribute the catch of very large trout over a longer time period by a delayed opening date. Wild rainbow trout in the Big Wood River spawn through June 15, more than 2 weeks after the general angling season opening day. In 1987 and 1988 large trout were caught early in the season and mean lengths declined rapidly thereafter. By delaying the opener until spawning is completed, large trout may be available for a longer period during years when low spring flows allow for above normal harvest. Although anglers harvest gravid trout during years with low stream discharge, the number harvested do not relate to the result and year class strength. We observed large year classes of trout associated with lower than average runoff and higher exploitation of adults in 1987 and 1988. Enhanced survival may result from the absence of spring flushing flows which scour redds. As a result of extensive stream alterations, the effect of spring flows is exaggerated and extensive bedload movement occurs.

Although the existing winter fishery has a minor effect on seasonal exploitation rates (5% of season), it is **a** volatile social issue. Many anglers oppose a consumptive winter fishery on the premise that large, wild trout are extremely vulnerable because they congregate in areas where anglers harvest them. Most anglers we interviewed supported the winter fishery. Our data does not support this premise. Implementing more restrictive regulations to enhance large trout during the general season would have **a** much larger benefit to enhancing large trout numbers.

The Role Of Catchable Rainbow Trout

Hatchery-reared rainbow trout have been introduced in large numbers throughout the Big Wood River drainage. Annual introductions to the mainstem exceeded 25,000 as recently as 1986. The intent of these introductions was to supplement the wild trout fishery. Hatchery trout comprize a majority (52%) of the total trout harvested in 1986 and 1987. Returns to the creel were variable between sections and averaged 48%.

Potential negative effects of stocking hatchery trout on wild trout should be addressed in the Big Wood River. Negative effects of stocking hatchery trout on wild populations have been observed by other researchers (Reisenbichler and McIntyre 1977; Krueger and Menzel 1979; Vincent 1987). Adverse effects may include: sustaining unusually large levels of angler effort which may suppress wild populations, displacement of wild trout into less suitable habitats, genetic introgression, and exposure to disease organisms. On the Big Wood River, hatchery trout have also displeased anglers by straying into the CR area from upstream sites. Petrosky and Bjornn (1988) found little evidence that catchable trout were able to displace wild trout, except at the largest stocking rates. Stocked trout did not occupy the same locations as wild trout. Although Vincent (1987) concluded that hatchery trout decreased the abundance of wild trout, other factors may have contributed to the decline he observed. If displacement occurs, the mechanism is poorly understood. The extent of hatchery trout introgression within the existing wild stock in the Big Wood River is also unknown.

If we segregate stocking sites, avoid excessive stocking densities, and improve the return rate of hatchery trout; the risks of displacement, genetic introgression, disease and conflicts with anglers can all be reduced. The current "wild" stock exhibits characteristics (fast growth rates and the potential to attain a large size) which should be maintained. An electrophoretic analysis could be conducted to determine if growth patterns in wild stocks may be genetically based. The analysis could also define the level of introgression of hatchery trout in the wild population. This information could help evaluate suitable areas to stock catchables. The IDFG Policy, which restricts distribution of diseased trout, should be implemented.

The following criteria could be developed to segregate stocking sites. Confine catchables to stream reaches:

1. Where natural recruitment is lacking or inadequate as a result of poor or limited habitat.

2. Which contain suitable access to produce large levels of angler effort.

3. Which contain suitable pools to hold stocked trout.

4. Which are currently fished by anglers who prefer a yield type of fishery.

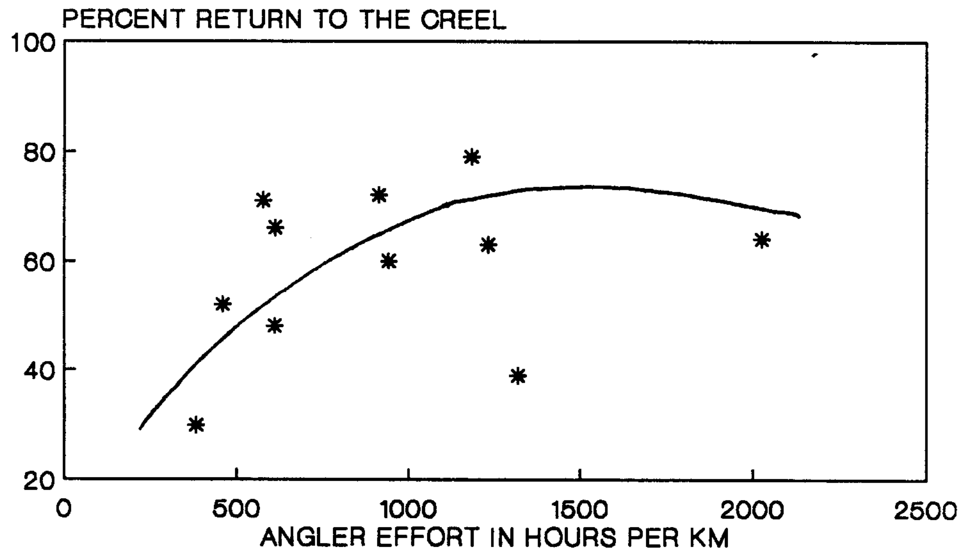
Reaches which do not meet all of these criteria could be removed as suitable stocking locations. Three reaches currently meet all criteria: Broadford bridge to Star bridge, Adams Gulch bridge to Hulen Meadows bridge, and areas upstream from the North Fork. One additional area in the vicinity of the KOA campground meets criteria 1-3, but could likely support a wild trout fishery if catchables were removed. Three tributaries (North Fork, Trail and Warm Springs Creeks) receive catchables and the proposed criteria could also be applied to them.

REGTEXT

The data base acquired on the Big Wood River might also be used to improve the efficiency of the catchable program and reduce potential adverse effects on wild trout by recommending stocking rates. Several variables, including access, angler effort, angler type, stream habitat, movements of stocked trout, and stocking rates, may effect return-to-the-creel of stocked trout. Our data suggests that as angler effort increased, return rate also increased (Figure 24). An asymptote may be approached at increasing levels of effort. Horner and Rieman (1985) also observed a relationship between angler effort and return-to-the-creel. A negative relationship may exist between stocking rates exceeding 300 trout/km and returns (Figure 24). Reduced return rate at high stocking rates may be a result of saturation of the area with trout. On the Big Wood River, wild trout densities (>200 mm) rarely exceeded 400 fish/km in the most suitable habitats, and averaged 30-100 fish/km in the upper reaches. Although introductions occur over several weeks, stocking relatively large (250-300 mm) hatchery trout at 300-800 fish/km may result in emigration of trout from the stocking sites into areas where they are less vulnerable to anglers. In addition, anglers may not be capable of catching a large proportion of the trout from very large stocking rates. Anglers harvested an average of 209 catchables per km from those sections where hatchery trout comprized a majority of the harvest. Kelley (1965) also reported an inverse relationship between large stocking rates and return-to-the-creel.

In the past, stocking rates for catchable trout have not been based on consistent guidelines. The proposed approach is an attempt to provide a more quantitative method for stocking catchables. To improve returns and reduce conflicts, stocking density should be related to the short term carrying capacity of the stream and the potential harvest by anglers. Trout should not be stocked at densities above the short term carrying capacity of the stream (Engstrom-Heg 1981). Most reaches of the Big Wood River, which meet the criteria for catchables, are not capable of supporting more than 100 trout/km, so no more than 100 trout/km should be stocked at a single time. If angler effort suggests 400 trout/km could be harvested annually, to attain a 70% return-to-the-creel, approximately 600 trout/km could be stocked requiring a minimum of **six** separate plants. In other reaches anglers may be capable of harvesting 200 trout/km, and to attain a 70% return-to-the-creel, approximately 300 trout/km could be stocked during the season. Several releases during the season could continually provide trout to anglers, improve return rate and reduce the risk of conflicts with wild trout. Consequently, the seasonal stocking density could be apportioned into a maximum number of individual releases. This approach may require additional effort by hatchery personnel but it could reduce the total number of catchables required and maximize returns.

If restrictive regulations are implemented to improve the abundance of large, wild trout in the bulk of the river, managers may need to maintain differential harvest regulations in areas receiving catchables. A uniform size limit would only be feasible if catchables were either clipped to allow differential harvest of hatchery and wild fish, or if catchables are stocked at a size which allows them to be harvested. Success of the catchable program may also be influenced by



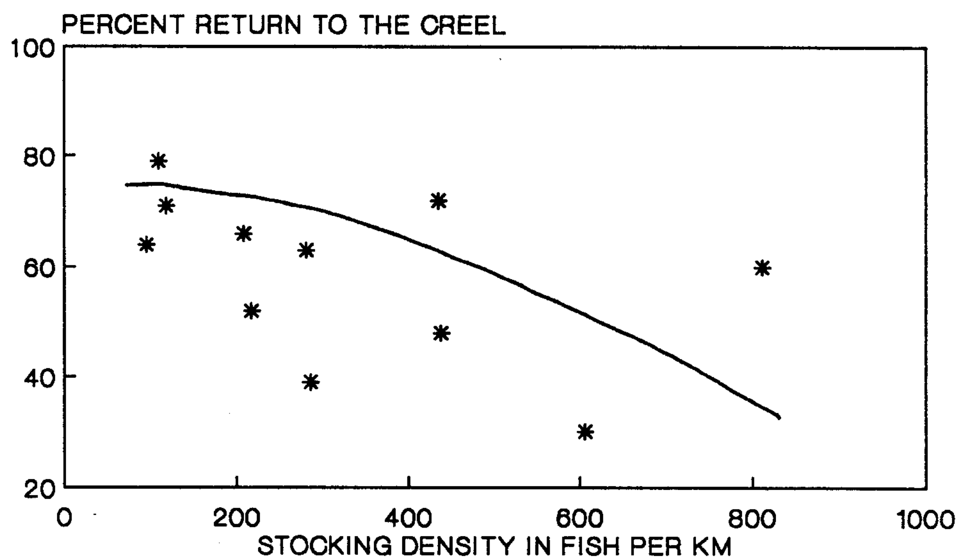


Figure 24. Relationship of catchable trout stocking density (bottom) and angler effort (top) to return-to-the-creel, lines fit by inspection.

public awareness of areas where catchable trout are released. To maximize returns, it could be beneficial to publicize stocking locations and schedules. By targeting yield oriented anglers to these locations, conflicts with other angler types in wild trout production areas may be reduced.

Additional research is needed to develop a quantitative approach to stocking catchable trout. Hartzler (1988) described the widespread lack of setting objectives for catchable trout programs and the associated lack of quantitative evaluations. As Horner et. al. (1988) observed, managers need better methods to predict return-to-the-creel and a definition of what constitutes "acceptable" return rates. Biologists should assess the influence of various stocking rates, levels of angler effort, and stream carrying capacities on return-to-the-creel. A suitable location for such an evaluation would allow researchers to manipulate the different variables and measure responses in adjacent treatment and control areas.

The potential benefits of increasing the number of releases could also be tested. A preliminary evaluation of multiple releases is being conducted on the Boise River in 1989 (B. Rohrer, Idaho Department of Fish and Game, personal communication). Finally, researchers should evaluate the response of anglers to the publication and targeting of catchable stocking times and sites.

Evaluation Of Responses

If more restrictive regulations are initiated on the Big Wood River, an evaluation of the biological response of the trout population and the sociological response of anglers should be conducted within 3 years. Explicitly stated management goals are necessary components of subsequent evaluations (Lewynsky 1986). The evaluation should be designed to determine if management goals have been met and the factors involved in the success or failure of the program.

Appropriate biological goals for the Big Wood River could include sustaining a viable wild population with a targeted size structure (%>300, %>400 mm) and maintaining a catch rate of one fish per hour. Goals could be segregated by the biological potential of the areas.

The data base collected from 1986-1988 provides pre-implementation data and future data collection will provide a description of responses. Identical electrofishing reaches and creel census sections established in 1986 (Figures 2,3) should be maintained as sampling sites. If more restrictive regulations are implemented on a section by section basis, this would provide an opportunity to evaluate the response of the population in both "test" and "control" areas. Such an approach would allow biologists to eliminate the variation from factors other than the regulation changes. A rigorous experimental design as Lewynsky (1986) called for is imperative for a reliable assessment of biological responses.

REGTEXT

Once goals are established and sampling sites are selected, the standardized methods employed during our research can be applied to evaluate the biological responses (see METHODS). Mark-recapture population estimates should be conducted in July. Estimates should be corrected for the size selectivity of the gear employed. Creel data should be collected during personal interviews with anglers on randomly selected days. Confidence intervals should be calculated for electrofishing and creel data. Data sets by sampling sites should include:

1. Site description (Maps of sampling sites will be maintained at the Region 4 office)

2. Mean width of electrofishing reach (each 100 m)

3. Surface area of electrofishing reach

4. Total length of electrofishing reach (from 1986-1988 data)

5. Length-frequency of wild rainbow trout

6. Total wild rainbow trout >200 mm, number per km, number per hectare

7. Total wild rainbow trout >300, >400 mm (corrected for size selectivity); number per km; number per hectare

8. Percent of wild rainbow trout >300, >400 mm

9. Catch, harvest, and release rate in fish per hour

10. Mean total length of wild rainbow trout harvested and the percent >300, >400 mm

11. Species composition of trout in the harvest

Evaluation of new regulations offers the opportunity to understand the effect of management decisions on the people who use the resource (Lewynsky 1986, Orbach 1980). Appropriate sociological goals for the Big Wood River could include: to maintain current levels of angler participation, maintain current levels of satisfaction, and avoid displacing anglers.

The Big Wood River is well suited to evaluate angler responses to new regulations. A similarly rigorous experimental design should be developed to evaluate sociological responses. Because of the inherent bias in opinion surveys and the potential response bias of mailout questionnaires, a social scientist review could help. reduce and compensate for bias. As mentioned earlier, stratification of regulations could provide an opportunity to evaluate test and control areas. Creel census data provides a pre-implementation description of angler types and attributes. Stratified random creel census techniques could be employed to describe post-implementation effort, angler types, and attributes. Angler opinion data was collected from two sources, on-stream interviews and a mailout questionnaire sent to a listing of participants. On-stream interviews could be replicated. A second mailing could be sent to those receiving the original questionnaire. The mailing could contain questions which are suitable to evaluate changes in angler participation and satisfaction. An appropriate question might assess whether some anglers were displaced to other waters or stopped fishing.

Finally, the Big Wood Riyer provides an opportunity to evaluate the economic values of a trout fishery managed under standard, restrictive, and possibly very restrictive regulations. Proponents of restrictive regulations often argue that such regulations enhance the economic benefits to local communities. An economic evaluation stratified by regulation type would provide important information.

A sound evaluation of regulation changes on the Big Wood River will assist in developing a comprehensive and effective plan for managing the Big Wood River and other waters of similar biological potential. The use of restrictive regulations with bait is of particular interest. If such regulations prove effective, their use in appropriate waters would enable managers to improve the size structure of trout populations without displacing bait anglers. As Martin (1976) observed, a key concern of fishery managers is to increase the resource base and provide maximum diversity of angling opportunity. The testing of regulatory tools would enhance the fishery managers ability to perform these tasks.

Limitations Of The Data

Several important uncertainties exist in the analysis. Actual recruitment mechanisms are unknown. We assumed that recruitment of new fish to the population was not stock dependent at current population levels, but was influenced primarily by density independent factors. Our observations of periodic, large cohorts during years with reduced flows tend to support this assumption. If actual recruitment is more variable and density dependent, benefits of different regulations could be more or less than anticipated. Also, because we assumed no stock-recruitment relationship, the simulations may not be useful in evaluating the response of total population abundance to various regulations. Since we collected no data in tributaries, their role in recruitment of trout to the river is unknown.

Our knowledge of natural mortality and exploitation is incomplete. However, our estimates of these parameters appear to be realistic because current natural mortality and exploitation must approach our estimates to approximate the existing population size structure and harvest. Based on our research on fish-habitat relationships in the river, habitat quality profoundly affects the standing crop of trout and natural mortality appears to be the primary factor which influences trout abundance. The relatively minor effect of even the most restrictive regulations on trout abundance supports this conclusion. Habitat capacity during the winter months may ultimately determine the carrying capacity of the system. Although simulations suggest minimal effects of compensatory mortality at large exploitation levels, if compensation occurs at lower exploitation levels, the benefits of restrictive regulations would be less than predicted. Trout protected from exploitation during the summer may succumb to natural mortality during the winter. This situation could be aggravated by continued habitat degradation which may reduce the trout population and mask any potential benefits from regulation changes. Hunt (1969) found that both the size of juvenile trout and winter water temperatures influenced overwinter survival, Activities which degrade habitat can reduce growth and increase the severity of water temperatures fluctuations. Both of these factors may reduce overwinter survival.

Slot limits which prevent anglers from harvesting most large trout may focus excessive harvest on smaller size classes and limit the abundance of large trout. Responses to size and bag limits in the simulations are based on the assumptions that anglers will continue to harvest few trout less than 200 mm. We also assumed anglers would continue to harvest trout between 200 and 300 mm at levels of exploitation similar to the current levels (0.5-0.65). If anglers begin harvesting large numbers of trout less than 200 mm and exploit trout between 200 and 300 mm at levels .exceeding 0.7, the benefits of slot limits will be reduced. This situation is most likely to occur with slot limits that restrict harvest to trout larger than 457 mm. Because these very large trout are uncommon in the population, anglers who wish to keep fish will focus the harvest on trout less than 300 mm. If anglers on the Big Wood River focus the harvest on trout less than 300 mm, the estimated percent of trout (>300, >400 mm) will decrease to 25% and 16%, respectively. More large trout would be produced under a less restrictive slot limit. On the Au Sable River, Michigan, a <305 >406 mm slot limit was implemented and anglers responded by harvesting more trout <305 mm and reduced the abundance of trout >305 mm by 47% (Clark and Alexander 1984). Anglers traded the harvest of 305-406 mm trout for trout less than 305 mm and restricted the number of large trout. On Idaho's Big Lost River, a <305 >508 mm slot limit has similarly focused the harvest on trout less than 305 mm (Elle and Corsi 1989). The authors suggest that modified regulations may be required if the abundance of large trout is to increase. Slot limits are designed to: 1) protect a fast growing segment of the population until it attains a large size, and 2) allow anglers to harvest some of the abundant younger age classes where compensatory mortality is most likely operating. However, if excessive harvest of younger age classes occurs, the benefits of a slot limit will be reduced or eliminated. Under those circumstances, a minimum size limit may be more effective than a slot limit in producing large trout (Clark and Alexander 1984).

We did not incorporate an estimate of the effect of hooking mortality on trout caught and released with artificial tackle into the model. We assumed the mortality was small and would not effect the results of the simulations. Numerous studies of hooking mortality suggest that a mean of 4-6% of the trout caught with flies and lures and released, die (Wydoski 1977; Mongillo 1984). Other investigators have documented hooking mortality estimates of less than 1% with artificial tackle (Dotson 1982; Schill et. al. 1986). If hooking mortality is larger, actual responses of the population to different regulations may be reduced. In addition, the difference in responses between regulations with and without bait would be diminished and the benefits of prohibiting bait overestimated.

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A P P E N D I C E S

Appendix A. Length frequencies of wild rainbow trout corrected for size selectivity, July-August, 1986-1988 pooled.

Reach	Percent by size group (mm)								
	100-149	150-199	200-249	250-299	300-349	350-399	400-449	450-499	500-549
1	47.4	31.6	12	5.1	1.8	1.6	0.4	0	0
2,3,4	56.2	22	11.2	5.9	2.1	1.5	0.9	0.09	0.01
5	48.4	28.6	17.2	4.4	0.5	0.4	0.4	0	0
6	40.8	30.8	15.1	5.7	3.1	3.1	1	0.1	0.1
7	36	37.2	20.5	4.3	2	0	0	0	0

Appendix B. Movements of wild rainbow trout tagged in spring, summer, and fall, and re-captured the same year and one year later.

	Percent of trout re-captured									
	Upstream (km)				Within	Downstream (km)				
Reach	>20	>10 <20	>5 <10	>1 <5	1 km	>1 <5	>5 <10	>10 <20	>20	N
	Spring of same year									
1	43	14	0	0	29	0	14	0	0	7
2,3,4	0	6	6	12	62	12	0	0	3	34
5,6,7	0	0	0	0	100	0	0	0	0	3
	Spring one year later									
1	--	--	--	--	--	--	--	--	--	0
2,3,4	0	0	0	0	80	20	0	0	0	5
5,6,7	--	--	--	--	--	--	--	--	--	0
	Summer of same year									
1	0	0	0	0	100	0	0	0	0	9
2,3,4	0	0	0	4	82	5	6	2	0	96
5,6,7	0	0	0	0	96	2	2	0	0	52
	Summer one year later									
1	- 0	0	0	0	100	0	• 0	0	0	1
2,3,4	4	0	9	9	52	13	9	4	0	23
5,6,7	0	0	11	0	80	0	5	5	0	21
	Fall of same year									
1	--	--	--	--	--	--	--	--	--	0
2,3,4	0	0	0	3	97	0	0	0	0	30
5,6,7	0	0	0	0	100	0	0	0	0	22
	Fall one year later									
1	--	--	--	--	--	--	--	--	--	0
2,3,4	0	3	3	6	65	21	3	0	0	34
5,6,7	0	0	0	5	95	0	0	0	0	19
									Total	35

Appendix C. Estimated angler effort (hours) by census interval and section, 1986 (95% confidence intervals in parentheses).

		Census section (km)								
Interval	Beginning	3 (9.2	4 (3.2 km)	6 (6.8 km)	7 (2.1 km)	8 (4.6	10 (3.7 km)	11 (8.3	12 (13.2 km)	Pooled estimate
1	Jun 14	93	113	474	50	309	62	103	154	1,308
		(111)	(125)	(655)	--	(111)		(206)	(230)	(919)
2	Jun 28	411	358	577	322	442	434	312	386	3,242
		(281)	(217)	(300)	(279)	(191)	(326)	(211)	(160)	(1,243)
3	Jul 12	875	280	395	375	585	460	390	695	4,055
		(553)	(188)	(258)	(332)	(346)	(215)	(344)	(254)	(1,138)
4	Jul 26	721	339	533	354	1,007	819	639	959	5,371
		(358)	(180)	(343)	(221)	(276)	(412)	(341)	(314)	(1,090)
5	Aug 9	827	399	882	678	873	743	669	1,551	6,621
		(318)	(328)	(249)	(500)	(437)	(301)	(596)	(830)	(1,781)
6	Aug 23	637	173	633	526	460	473	633	695	4,229
		(383)	(164)	(533)	{325)	(248)	(291)	(493)	(242)	(1,846)
7	Sep 6	176	38	134	80	298	67	448	243	1,483
		(127)	(47)	(140)	(128)	(248)	{91)	(331)	(101)	(655)
8	Sep 20	139	131	186	162	91	107	79	146	1,041
		(134)	(112)	(175)	(117)	(99)	(112)	(106)	(159)	(502)
9	Oct 4	101	28	60	47	65	107	84	71	562
		(84)	(33)	(53)	(45)	(49)	(96)	(100)	(105)	(233)
10	Oct 18	148	42	263	70	0	176	271	9	979
		(217)	(27)	(222)	(111)		(320)	(51)	(17)	(253)
11	Nov 1	40	33	0	47	13	0	50	13	147
		(46)	(67)	--	(72)	(27)	--	--	(27)	(81)
Total	Jun 14-Nov 14	4,168	1,934	4,137	2,711	4,143	3,448	3,678	4,922	Grand total:
Pooled total	estimate	4,222	1,954	3,919	2,769	4,205	3,484	3,635	5,035	29,222
		(1,116)	(565)	(931)	(881)	(1,011)	(920)	(1,061)	(1,355)	(7,840)
Estimated hours per kilometer		459	611	576	1,319	914	942	438	382	572

Appendix D. Estimated angler effort (hours) by census interval and section, 1987 (95% .confidence intervals in parentheses).

		Census section (km)							Pooled estimate
Interval	Beginning	1 {10.5 km)	2 (5.7 km)	4 (3.2	5 (4.6 km)	7 (2.1 km)	9 (2.4	11 (8.3 km)	(by interval)
A	May 23	909 (551)	20 (40)	263 (173)	348 (237)	278 (141)	129	66 (94)	1,992 (817)
B	Jun 6	196 (141)	0	108 (158)	36 (55)	26 (51)	26	26	417 (340)
1	Jun 13	860 {474)	129 (202)	278 (214)	464 (554)	191 (174)	108	108 (160)	2,137 (1,379)
2	Jun 27	549 (353)	0	414 (293)	649 (317)	675 (341)	94	953 (517)	3,334 (1,031)
3	Jul 11	660 (512)	0	610 (556)	580 (487)	490 (214)	150	800 (270)	3,270 (1,136)
4	Jul 25	688 (264)	0	387 (235)	552 (273)	424 (227)	133	608 (237)	2,606 (702)
5	Aug 8	297 (252)	0	548 (344)	762 (374)	594 {308)	511	905 (399)	3,571 (1,596)
6	Aug 22	257 (165)	0	403 (168)	296 (193)	434 (281)	35	885 (682)	2,291 (1,022)
7	Sep 5	140 (92)	0	423 (408)	499 (399)	543 (160)	63	461 (301)	2,129 (899)
8	Sep 19	19 (103)	0	190 (138)	340 (348)	261 (205)	44	356 (220)	1,266 (770)
9	Oct 3	37 (59)	0	90 (129)	418 (404)	127 (30)	75	269 (303)	1,001 (795)
10	Oct 17[a]	37	0	90	418	127 (30)	75	269	1,001 (795)
11	Oct 31	33 (67)	0	0	80 (136)	13 (27)	0	13	140 (125)
Total	May 23-Nov 13	4,754	149	3,804	5,442	4,183	1,443	5,719	Grand total
Pooled estimate (by section)		4,616 (1,175)	"143	3,943 (1,026)	5,446 (1,214)	4,255 (831)	1,469 (513)	5,881 (1,484)	25,753
Estimated hours per km		440	25	1,232	1,184	2;036	612	709	

[a]No counts completed; effort estimated to be similar to previous interval. In 1986, effort during Interval 10 was > Interval 9 in six of seven sections.
[b]Section 2 was dewatered during Interval 1.

Appendix E. Estimated angler effort (hours) by census interval and section, 1988 (95% confidence intervals in parentheses).

		Census section		
Interval	Beginning	4 (3.2 km)	6 (6.8 km)	7 (2.1 km)
A	May 28	117 (78)	162 (73)	106 (55)
B	Jun 4	118 (107)	123 (110)	72 (65)
1	Jun 11	402 (192)	144 (100)	273 (113)
2	Jun 25	736 (320)	1,041 (506)	725 (370)
3	Jul 9	463 (157)	830 (398)	332 (159)
4	Jul 23	288 (187)	440 (304)	234 (147)
5	Aug 6	576 (175)	612 (201)	173 (123)
6	Aug 20	210 (137)	1,148 (295)	402 (157)

Appendix F. Total estimated harvest, catch, and catch rates of trout; 1986 and 1987.

		Harvest					Catch[y]			Fish per hour	
				Wild	Total harvest		Total catch				
Section	Year censused	Hatchery rainbow trout	Brook trout	rainbow trout	#	1i/km	#	#/km	Released %	harvest (fish/h)	catch (fish/h)
1	1987	258	80	1,151	1,985b	189	4,662	444	57	0.43	1.01
3	1986	1,030	17	642	1,689	183	3,800	413	56	0.40	0.89
4	1986	671	0	853	1,524	476	2,813	879	46	0.78	1.44
	1987	568	38	1,287	1,893	591	4,652	1,454	59	0.48	1.18
5	1987	395	36	1,366	1,797	297	3,889	1,433	73	0.33	1.22
6	1986	565	0	611	1,176	173	5,172	761	77	0.30	1.32
7	1986	235	0	706	941	448	4,348	2,070	78	0.34	1.57
	1987	127	0	852	979	466	5,022	2,391	81	0.23	1.18
8	1986	1,443	0	407	1,850	402	4,289	932	57	0.44	1.02
9	1987	332	22	190	544	227	2,718	1,132	80	0.37	1.85
10	1986	1,789	0	476	2,265	612	4,390	1,186	48	0.65	1.26
1 1	1986	------------------Catch-and-release			-------------		7,088	854	100		1.95
	1987						10,468	1,261	100		1.78
12	1986	2,366	0	555	2,921	221	3,726	282	23	0.58	0.74
Total[c]	8,873		193	7,537	17,099		67,037	744	66		
Percent of total		52	1	44							

[a]Includes number harvested + number released.
[b]includes 496 brown trout, 3% of total.
[c]Most recent year included.

RTAPP2

Appendix G. Catch_and harvest rates (fish/h) by census interval, sections 4 + 7 pooled, 1986-1988.

	Catch rate			Harvest rate		
Interval	1986	1987	1988	1986	1987	1988
A	-	0.51	0.57	-	0.06	0.28
B	-	0.4	0.97	-	0.07	0.45
1	0.50	0.96	1.28	0.50	0.18	0.61
2	1.21	1.39	1.61	0.62	0.37	0.39
3	1.26	1.42	1.67	0.55	0.42	0.24
4	1.39	1.14	1.44	0.68	0.45	0.19
5	1.59	1.03	1.43	1.12	0.31	0.24
6	0.50	1.06	1.48	1.17	0.22	0.17
7	2.04	1.26	-	0.51	0.42	-
8	2.18	1.03	-	0.28	0.35	-
9	1.66	0.56	-	0.17	0.10	-
10	1.07	0	-	0	0	-
11	0.38	0	-	0	0	-

Appendix H. Estimated return-to-the-creel of hatchery rainbow trout stocked in sections of the Big Wood River, 1986 and 1987.

Section	Estimated hatchery trout stocked No.	Estimated hatchery trout stocked No./km	Estimated harvest No.	Estimated harvest No./km	return-to-the-creel
1986					
3	2,000	217	1,030	112	52%
4	1,400	438	- 671	210	48%
6	800	118	565	83	71%
7	600	286	235	112	39%
8	2,000	435	1,443	314	72%
10	3,000	811	1,789	484	60%
12	8,000	606	2,366	179	30%
Total	17,800	416	8,099	189	46%
1987					
4	900	281	568	178	63%
5	500	109	395	86	79%
7	- 200	95	127	61	64%
9	500	208	332	138	66%
Total	2,100	171	1,422	116	68%
Grand total	19,900	361	9,521	173	48%

Appendix I. Angler residence and methods as percent of total, 1986-1988.

Section	Year	Residence		Methods				
		Res.	Nonres.	Bait	Lure	Fly	Multiple	N
1	1987	90	10	60	11	19	10	162
3	1986	69	31	54	7	36	3	124
4	1986	75	25	63	13	22	2	32
	1987	80	20	48	9	36	7	167
	1988	85	15	46	11	29	14	151
5	1987	66	34	30	8	58	4	146
6	1986	53	47	47	5	41	7	59
7	1986	40	60	34	6	60	0	47
	1987	53	47	31	5	59	5	174
	1988	78	22	27	3	63	7	125
8	1986	51	49	58	9	33	0	74
9	1987	48	52	29	7	59	5	56
10	1986	56	44	64	9	27	0	48
11	1986	32	68		2	98	0	53
	1987	35	65		1	99	0	215
12	1986	60	40	53	8	33	7	64
Totals[a]		67	33	46	8	41	5	1,074

[a]Excluding Section 11. Most recent complete census year included.

Appendix J. Estimate percentage of the catch by anglers using various methods.

Method	Stream section									
	1	3	4	5 -	6	7	8	9	10	Average
Bait	.57	.59	.36	.25	.36	.19	.45	.24	.56	.35
Lure	.06	.03	.16	.11	.01	.10	.02	.03	.01	.08
Fly	.21	.37	.41	.60	.56	.71	.53	.71	.43	.52
Combination	.16	.01	.07	.04	.07	<.01	0	.02	0	.05

RTAPP1

Appendix K. Angler opinion survey results, Big Wood River, 1987.

Specific questions posed to anglers and their responses (as percentages):

1) How many days per year do you fish the Big Wood River?

Response by section	<5	5-10	>10	N
1	74	17	9	23
4	24	27	49	33
5	31	24	45	42
7	30	17	53	30
9	43	0	57	7
Total	37	21	42	135
11	39	35	26	69

Response by method	<5	- 5-10	>10	N
Bait	30	18	52	50
Lure	20	20	60	5
Fly	33	26	41	76
Multiple	100	0	0	10
Fly (Section 11)	40	34	26	68

2) How would you rate your fishing trip?

Response by section	Excellent	Good	Fair	Poor	N
1	4	52	18	26	23
4	24	61	15	0	33
5	23	75	2	0	43
7	20	47	30	3	30
9	20	80	0	0	5
Total	20	61	14	5	135
11	32	43	24	1	68
Response by method					
Bait	16	61	18	5	44
Lure	20	60	20	0	5
Fly	24	63	12	1	75
Multiple	0	50	10	40	10
Fly (Section 11)	33	43	24	0	67

3) Is more public access for fishing needed on the Big Wood River?

Response by section	Yes	No	N
1	35	65	23
4	28	72-	32
5	28	72	40
7	47	53	30
9	17	83	6
Total	33	67	131
11	31	69	67

Response by method	Yes	No	N
Bait	45	55	44
Lure	0	100	4
Fly	28	72	74
Multiple	22	78	9
Fly (Section 11)	32	68	66

4) Are you satisfied with the current size and abundance of trout?

Response by section	Yes	No	N
1	52	48	23
4	75	25	32
5	76	24	42
7	75	25	28
9	100	0	5
Total	72	28	130
11	68	32	65

Response by method			
Bait	70	30	43
Lure	80	20	5
Fly	77	23	73
Multiple	44	56	9
Fly (Section 11)	68	32	65

5) Would you support more restrictive regulations on sections of the Big Wood River if these regulations increased the size and abundance of trout?

Response by section	Yes	No	N
1	86	14	22
4	88	12	33
5	90	10	42
7	86	14	29
9	100	0	7
Total	89	11	133
11	97	3	67
Response by method			
Bait	88	12	43
Lure	100	0	5
Fly	93	7	75
Multiple	50	50	10
Fly (Section 11)	98	2	66

6) Do you support the stocking of hatchery rainbow trout-to maintain harvest opportunity in some sections of the Big Wood River?

Response by section	Yes	No	N
1	91	9	22
-4	88	12	32
5	88	12	41
7	86	14	29
9	100	0	7
Total	89	11	131
11	92	8	66
Response by method			
Bait	95	5	44
Lure	100	0	5
Fly	82	18	72
Multiple	100	0	10
Fly (Section 11)	92	8	65

7) Stream alterations (channelization, floodplain development, snag removal, riprap) have adversely affected fish populations in the Big Wood River by decreasing the amount of habitat.

Do you favor measures to prevent further floodplain development and stream alterations?

Response by section	Yes	No	N
1	73	27	22
4	91	9	33
5	95	5	42
7	93	7	28
9	67	33	6
Total	89	11	131
11	93	7	67
Response by method			
Bait	89	11	44
Lure	80	20	5
Fly	92	8	73
Multiple	67	33	9
Fly (Section 11)	92	8	66

8) Do you support the current winter fishery which allows harvest of trout?

Response by section	Yes	No	N
1	53	47	19
4	87	13	31
5	69	31	32
7	79	21	28
9	50	50	6
Total	72	28	116
11	62	38	61
Response by method			
Bait	83	17	35
Lure	80	20	5
Fly	70	30	67
Multiple	44	56	9
Fly (Section 11)	63	37	60

Appendix K. Continued.

9) Section 1 only. In recent years, brown trout have been increasing in lower sections of the Big Wood River. What is your opinion of this increase?

Response	Support	Oppose	No opinion	N
Section 1	75	10	15	20
Response				
Bait	55	18	27	11
Lure	100	0	0	1
Fly	100	0	0	3
Multiple	100	0	0	5

Appendix L. Statewide angler opinion survey results for anglers listing the Big Wood River as their most frequently fish water (Reid 1989).

Questions posed and responses as percentages:

16) Increased fishing pressure has reduced wild trout populations in some Idaho streams. To maintain fishable populations, would you favor?

Restrict the number or size of trout that could be kept: 73%

Replace wild trout with hatchery trout: 18%

No opinion: 9%

17) Would you like to have additional streams or lakes managed to provide larger than average trout and increased catch rates, even knowing that methods of fishing and numbers and size of fish that could be kept would be restricted?

Yes: 67%   No: 23%   No opinion: 10%

19) Please indicate the programs you feel should receive more or less emphasis:

Protection and enhancement of wild trout?

More: 82%   Less: <1%   No Change: 17%

Hatchery trout production for streams?

More: 57%   Less: 7%   No Change: 37%

Habitat protection?

More: 81%   Less: 0%   No Change: 19%

20) If you had to release all of the trout you caught from your favorite trout stream, would you continue to fish that stream?

Yes: 58%   No: _40%   No opinion: 2%

21) If a stream or lake could provide the opportunity to catch a trophy . trout, would you fish that stream or lake, even if you had to release all the fish you caught?

Yes: 69% No: 29% No opinion: 2%

31) Preferred water type?

Stream/ River	Lake/ Reservoir	Mountain Lakes
88%	9%	3%

32) Preferred method of fishing?

Bait	Lure	Fly	No opinion
24%	16%	50%	10%

34) Level of satisfaction while fishing rivers and streams for trout.

Excellent	Good	Fair	Poor
23%	46%	25%	5%

35) Importance of various factors in selecting where to fish.

	Crucial	Very Important	Important	Somewhat Important	Not - Important
Catch rate of keepable fish	8%	13%	24%	25%	30%
Catch rate of all fish	8%	18%	27%	24%	-24%
Chance to catch a large or trophy fish	9%	26%	24%	19%	21%
Chance to catch wild fish	15%	30%	24%	16%	14%

Appendix L. Continued.

36) Reasons why you fish:

	Crucial	Very Important	Important	Somewhat Important	Not Important
To catch fish	18%	33%	30%	16%	3%
For relaxation	29%	43%	23%	4%	1%
To enjoy nature	33%	42%	20%	5%	<1%
Chance to catch trophy fish	9%	15%	14%	26%	36%
Catch fish for consumption	7%	8%	18%	26%	41%

Appendix M. Summary of population responses to varying regulations at current exploitation levels (E) in the lower (E = 0.6) and upper (E = 0.7) Big Wood River.

	Lower river			Upper river		
	% of trout			% of trout		
Regulation	>300 mm	>400 mm	Harvest (#)	>300 mm	>400 mm	Harvest
Current						
w/bait[a]	23	4	366	9	0.5	214
bait + bag[b]	31	10	317	13	1.0	177
>406 mm						
no bait[c]	51	26	156	29	8	25
w/bait	37	14	279	17	3	137
bait + bag	38	15	270	17	3	135
>305 mm						
no bait	36	6	250	21	2	74
w/bait	30	5	312	14	1	151
bait + bag	35	11	287	16	2	144
>254 mm						
no bait	29	5	320	16	1	128
w/bait	26	4	344	12	0.5	173
bait + bag	33	10	305	15	1	154
<305 >406 mm						
no bait	37	19	304	13	3	196
w/bait	30	11	339	10	1	206
bait + bag	34	14	301	14	2	171
<305 >457 mm						
no bait	40	23	284	14	4	193
w/bait	31	12	334	11	2	206
bait + bag	35	15	298	14	3	171
<305 >508 mm						
no bait	43	27	262	14	4	190
w/bait	32	13	330	11	2	205
bait + bag	36	15	294	14	3	170
<254 >406 mm						
no bait	46	23	218	21	6	127
w/bait	34	13	306	14	2	175
bait + bag	36	15	286	15	3	173

[a]6 fish bag limit with trout.
[b]2 fish bag limit with trout.
[c]artificial flies and lures only.

Appendix N. Summary of population responses to varying regulations with hooking mortality rates of 60%, and 602 of the catch by bait anglers at current exploitation levels (E) in the lower (E = 0.6) and upper (E = 0.7) Big Wood River.

	Lower river		Upper river
Regulation	Number of trout >200 mm	Percent increase in hooking mortality relative to current conditions	Number of trout >200 mm
>406 mm	791	78	382
>305 mm	711	24	368
>254 mm	675	7	356
<305 >406 mm	711	11	346
<305 >457 mm	723	17	346
<305 >508 mm	730	26	346
<254 >406 mm	755	40	362
Current	651	--	338

RTAPP1

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